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HENRY H. SIBLEY, St. Paul,
WM. R. MARSHALL, St. Paul.
THOMAS S. BUCKHAM, Fariba
RICHARD CHUTE, Minneapolis
A. J. EDGERTON, Kasson.
GREENLEAF CLARK, St. Paul.
O. V. TOUSLEY, Minneapolis.

JOHN S. PILLSBURY, Governo
*D. BURT, Superintendent of Pu
WM. W. FOLWELL, President

*Deceased.

AD

To W. W. FOLWELL, President of

Dear Sir:—The accompanying re
Geological and Natural History Sur
the tenth annual report. In thus re
nual reports on the Geology and Nat
the University and the State may be
tended the enterprise, a large share o
of the law by which the survey is car
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The University of Minnesota, Minneapo

REPORT.

I.

SUMMARY STATEMENT.

The field work has been continued by Mr. Upham, aided in July and August by Mr. H. V. Winchell. The field of examination has been the north-central and northwestern portions of the State. These counties are almost entirely covered with a heavy sheet of drift, and necessarily, most of the recorded observations and investigations have related to the surface geology, and a large fund of valuable information has been added by Mr. Upham to the historical geology of the Quaternary Age. That ancient body of inland water which in former reports has been styled *Lake Agassiz*, has been found to have extended its highest shore line far toward the east, in the northern part of the State, probably including within its limits the present Red and Rainy lakes, and the Lake of the Woods, giving the well known topographic features of the Red River Valley, to a much larger extent of territory in Minnesota than had formerly been supposed, even quadrupling the known area pertaining to the valley as heretofore limited. Not only is this a valuable accession to the known agricultural capabilities of Minnesota, but the results attained in other directions, are equally valuable to science. The beach lines of Lake Agassiz have been subjected to a careful inspection over a distance north and south of about one hundred and seventy-five miles, resulting in the discovery of some peculiarities which have a direct bearing on their formation and history, and aid in filling out an obscure chapter in the geology of the Ice Age. Some of these peculiarities may be mentioned briefly.

The lake had three stationary periods, forming three beaches. They all ascend above a given datum level toward the north, the rate increasing in going toward the north. The highest beach line ascends one hundred and twenty-five feet in about one hundred and fifty miles, the beach being one continuous shore line. The northern portion of the lake fell at intervals from this high beach-line, forming lower beaches successively at about eight, fifteen, thirty, and forty feet, while the water level in the extreme southern part stood nearly stationary, the northern fractional beaches converging into one toward the southern extremity of the lake. The next distinct beach found in the southern part of the region ascends toward the north seventy feet in one hundred and fifty miles. The surface of the lake had now fallen thirty feet in Traverse and Grant counties, fifty feet in northern Clay county, and ninety feet northwest of Maple lake. The fall of the lake had therefore been sixty feet more at the northern than at the southern end. Double and multiple ridges occur along the northern half of this distance. The third beach-line, formed when the outlet had been excavated to the level of Lake Traverse, is known along a distance of one hundred and thirty-five miles, and its northward ascent was at first fifty feet and and afterward only about twenty-five feet. Toward the northern extent of this beach are also additional lower beaches, indicating a halting descent of the water level. The fall of Lake Agassiz from the highest beach level to the third, at Lake Traverse, was about eighty feet, and in the vicinity of Maple Lake one hundred and sixty-five feet. But the rate of ascent of this third beach-line is less in the northern portion than toward the south. These phenomena seem inconsistent with that hypothesis which supposes an elevation of northern land as a barrier to contain this vast inland lake, inasmuch as these beaches would have to present a slope in the opposite direction in order to change the outlet from Lake Traverse to Hudson's Bay. The same kinds of beaches appear about the southern shores of Lake Erie and Michigan, and have often been referred to in geological reports They have been ascribed to the operation of the glacial period in the epoch of its decline, when the ice still existed toward the north as a barrier to prevent northern drainage. The same obstruction must have existed in the Red River Valley, and in the opinion of Mr. Upham, its attraction was sufficient to move the mass of the water toward itself and to cause an ascending shore line in that direction. Any such barrier, operating inversely as the squares of its distance from different parts of the lake, would thus cause a more rapid ascent in those portions of the shore line near it than in those more remote.

Lake Agassiz, probably covered Red Lake under fifty or one hundred feet of water above its present level, Lake of the Woods under about two hundred feet, the Red River Valley at St. Vincent, four hundred and fifty feet, and Lake Winnipeg, about six hundred feet. It is supposed to have extended east as far as the east end of Rainy Lake, but no definite statements can be made yet concerning the northern slope of the State between Red Lake and Vermilion Lake.

The distribution and characters of the crystalline rocks in the central portion of the State, including the counties of Stearns, Sherburne, Benton, Morrison, Mille Lacs, Kanabec, Aitkin and Todd, and portions of Carlton and Pine, have also been ascertained by Mr. Upham.

The failing health of Mr. C. M. Terry, rendered it necessary for him to suspend active work about the middle of May. A trip to Florida afforded him no relief, still he was preparing to resume work on the survey in the latter part of summer, when he was taken worse and he died.

His contribution to the last report of progress, pertaining to the Hydrology of the State, shows the carefulness and the scope of his work. His perseverance and industry were remarkable, and the amount he accomplished, with his feeble health, was a surprise to those who knew the obstacles under which he labored. He has left some maps, notes, and incomplete manuscript, which will be made to contribute in his name, to the completion of the subject to which they pertain. I cannot forbear at this place, giving testimony to his uniformly, cheerful disposition and urbane personal bearing, his high integrity, his zeal and industry, and his truly scientific methods of work and thought. Having spent some years in the christian ministry, one of the most instructive facts of his brief labors for the survey, is the ease and quickness with which he turned himself to purely scientific pursuits. He began with careful laboratory work, requiring patient mechanical manipulation, and he succeeded from the outset. Whatever he undertook, he knew how to accomplish at once. Having a trained mind, it was no task for him to apply it vigorously and persistently, in a new field of labor. A general suggestion, or an intimation as to the direction to be given to his labor, was all that was necessary. Had he been able to finish the work that he had in hand, one of the most useful, thorough and instructive chapters of the final report of the survey would have been written by him.

Mr. C. L. Herrick continued to work in the laboratory of the survey and in the Museum, till the first of July. He sailed for Europe in September, and is studying in Leipzig. A contribution of his to the survey reports has been under way ever since the publication of his paper on *Microscopic Entomostraca* in the seventh annual report.

My personal labor has been given to the preparation of chapters for the final report. which, with the prosecution of the building-stone investigation, the office and executive duties, and the conduct of the last annual report through the press have occupied my whole time. It has been necessary to visit most of the quarrying localities in order to obtain samples of suitable size for use in the examination of the building-stones of the State. At the same time the quarrying statistics of the State were furnished the U. S. census for 1880, and additional samples were forwarded to Washington to be subjected to a careful analytical examination by the government, calculated to further elucidate the nature of the rocks of Minnesota.

In the Museum report will be seen the recorded additions to the collections, and their sources. No important purchases or changes have been made either in the material of the collections or arrangements of the Museum rooms. There will be no occasion to make important changes before the erection of the new building for the use of the Museum, which has been ordered by the State legislature. Indeed, it would be poor policy to lay out much more expense on the old rooms. In the new building it is expected better accommodations will be afforded not only for the exhibition of the specimens, but also for the handling and examination of the various classes of rocks. The thanks of the University are due to Col. J. B. Clough, for fossil specimens of extinct vertebrates from Montana, and for Indian implements, for the General Museum, and for other specimens, and to O. E. Garrison, for procuring samples of water from Mille Lacs; and to Dr. —— Miller, of the Little Missouri Cantonment, for a collection of fossil leaves from that locality.

The survey is also under obligations to Prof. A. H. Chester, of Hamilton College, N. Y., for a report on the geology of the iron region east of Vermilion Lake, based on observations made by him during two seasons spent in that part of the State exploring for iron in the interests of non-resident capitalists. The report of the survey for the year 1878 called attention to the existence of iron ore in the northern part of the State in large quantities, and to the fact that parties interested in iron from eastern States have made costly surveys and examinations, attesting the value of these deposits by field exploration, and by laboratory assay. Since then others have become interested in the same way, and it is not premature to predict that the iron ore of Minnesota will, not many years hence, be largely wrought, and yield to the State a revenue which will be commensurate with the extent of the deposits and the importance of such industry. It would be well if the capatalists of Minnesota would look after this matter, and by concerted action, retain within the State as much as possible of the profits of such development of these ores. The blast furnace which is now in operation at Duluth, using ores from Marquette, should be supplied from Minnesota, and Minnesota railroad companies should see to it that these ores are made accessible. Our iron ores are the farthest west of all the Lake Superior deposits, and being in the midst of timbered lands are situated favorably for reduction by charcoal; while the great region west and northwest, destitute of the rocks producing these ores, will always have to depend on us for iron and its products in the same manner as for lumber. Eastern iron deposits and eastern furnaces should not be allowed to find it profitable to send their products past our doors when we have every requisite and every facility for producing the same. It would be a thing highly creditable to the Regents and to the University, to be directly instrumental in developing this great industry, and I hope that general attention may be called to its feasibility.

I wish to call your attention again to the destruction of the forests by fire in the northern portions of the State, and to refer you to representations made in the report for 1878, (p. 24) and again in the report for 1879, (p. 134). The Legislature should be asked to enact the necessary laws, with penalties, to preserve the forests, and especially the pine forests, from destruction. These fires are not occasional, but seem to be habitual. No country in the world, claiming to be a civilized and enlightened commonwealth, should permit such wanton destruction of the public domain for one moment when once informed of it, and it would not be possible were it not for the sparseness of the inhabitants, and the indifference to the public interests too often exhibited by republican Legislatures. It would be well if co-operation could be had with the Canadian government in any effort to suppress these fires, since they originate on both sides of the international boundary. The The University pine lands, on the St. Louis river, are annually in danger of being devastated.

II.

PRELIMINARY LIST OF ROCKS

COLLECTED BY N. H. WINCHELL IN 1879—CONTINUED FROM THE LAST REPORT.

FROM FOND DU LAC TO KNIFE FALLS.

443. The red sand rock at Fond du Lac. This dips E. S. E., or S. E., about ten degrees.

443A. Quartz pebbles from No. 443.

444. About the center of S. W. ¼, sec. 6, 48, 15. Here a bed of dark-red shale strikes across the bluff. This is about eighteen feet thick, and has thin beds of sandstone occasionally, much as the limestone is embraced in the shales of the Hudson river formation. This shale has spots that are greenish. Pieces of the same color (and also red) are sometimes seen in the midst of the massive sand rock (443) which, on weathering out, (where quarried,) give the rock a loosely porous and (apparently) conglomeritic structure. There are belts and thin strips, parallel with the bedding, that are conglomeritic with white, or glassy (not milky,) water-worn quartz pebbles, that are sometimes larger than hen's eggs, but the great mass of the whole is a homogeneous sandrock. They are sometimes more shaly, and also on separating some of the thin layers, they even show micaceous interlamminations. The general color is a dark red-brown, like the brown sand rock of the "brown fronts," but it has layers that are of the ordinary light-colored sand rock. This light color is sometimes disseminated through the red in round spots or specks, or is clouded and mottled in it over considerable areas. Sometimes a solitary quartz pebble, as large as a walnut, is seen in the otherwise homogeneous brown sand rock; and occasionally one is as large as a man's fist.

Below the above-mentioned bed of dark-brown or red shale, the rock is altogether less firm and siliceous than it is above, or to the east. After a thickness of about twelve feet of rock, somewhat like the rock overlying, another bed of shale, or shaly rock, is met with, whose extent cannot be defined, as it seems to alternate with thin bands of shaly sand rock confusedly, the latter having cross-stratification, until finally the whole formation, so far as seen in the bluff, almost deserves to be styled a shale. It resembles the red shaly sand rock of Good Harbor Bay, near Grand Marais. It sometimes weathers out in slates, (less than one-fourth inch thick) which are flexible, and red like the rest, but rather fragile. It has belts of green shale running parallel with the bedding. There is a thickness of about thirty feet of this shale visible along the river by the railroad, before it is hid again by trees and talus. It becomes all shale. The apparent horizontality is due to a change of direction in the bluff. Some of it is quite siliceous, but in very thin sheets. The brick-red color is sprinkled with light spots; and there are belts, three or four inches thick, of a light bluish-green color. The green color, indeed, seems to be the original color, and prevails largely on tearing down a lot of the layers. Although following the layering in belts, or elongated with the bedding, yet these light-green spots are also globular, or oblate spheres passing through several sheets of the thin shale, which shows no change but that of color.

At the high bridge, "No. 1," which is over a little creek at center of sec. 1, 48, 16, the formation shows about the same dip, but is more nearly a sandrock again, but still with alternating layers of slaty sandrock, (often with cross-bedding,) and red aluminous shale in thin layers; but where the creek joins the river there is a bed of about three and one half feet of red, crumbling, conglomerate. This lies below the shale last mentioned, and has below it an exposure of about six inches of cross-bedded sandrock. Thus, in ascending the creek, the layering is as follows, No. 1 being the lowest:

1.	Cross-bedded sandrock, next the water	6 in.
2.	Crumbling conglomerate, rather fine	3½ ft.
3.	Shale, with layers of six and eight inches of shaly sandrock with cross-bedding	4 ft.
4.	Shale	18 in.
5.	Sandrock	8 ft.
6.	Like No. 3	12 ft.
	Total	29 ft. 6 in.

The above section is all on the lower side of a *fault*, i. e., on the river side, and on the left bank of the creek. Above the fault, which is hid on the opposite side of the creek, the visible section consists of the following:

1.	Crumbling conglomerate, rather fine	3½ ft.
2	Shaly sandrock, with belts of greenish, shaly sandrock and of shale	10 ft.
	Total	13½ ft.

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	18 in.
	8 ft.
	12 ft.
	29 ft. 6 in.

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the creek, the visible section consists of

r fine	3½ ft.
reenish, shaly sandrock and of shale	10 ft.
	13½ ft.

It seems as if the conglomerate h
distance of about fourteen feet, b
beds at the fault, indicating a subs
inches, after the fault had closed up.

446. Black roofing slate, near th
in town 49, 15, in the bottom of a b
spicuous exposure, covered in high
across the creek east and west.

447. Nearly on the town line, ne
the northwest, in the bottom of Mi
ored slate than the last, but related
direction and rises about four feet i

448. Crumbling, red conglomera
Louis, at a point near the bridge ("
but lower in the formation than th
bed is fifteen feet thick, shows a stro
ing the creek, by two feet of shaly
of shale not well exposed. Under t
be seen six feet of red conglomera
extending along the bank so as to
fifty feet.

449. Below the last appears thi
ferous, pebbly conglomerate, consist
is seen on S. W. ¼ of N. E. ¼ Sec.
beds, about 10° E. of S., by compa
three inches across. The pebbles
are translucent. Some are black o
half of the gravel is of the under
the junction of the two creeks th
two inches thick, running north a
conglomerate extends a few rods a
before it disappears, which it does
left bank in accordance with the d
ding; and within the distance of
formation appears in the bed of th
able exposure along the bank. T
as the weathering separates the c
and west, as at Thomson. But i
lower where it is last seen in the be
first appears, and so low that even
tend to throw it higher in ascend

the slate. Hence it is probable that the conglomerate lies in depressions in the slate surface, and is thicker in some places than in others. At this place the contact is not visible, but there cannot be much between the points seen on each side. So that, as already stated, there is too much conglomerate to fill the unseen interval. This conglomerate appears conspicuously on the St. Louis, S. E. ¼ Sec. 2, T. 48, 16. (For a complete section of the red sandrock beds, see after No. 510).

450. Samples of the Thomson slate, from the river bank, S. E. ¼ Sec. 2, T. 48, 16, underlying the conglomerate, No. 449.

451. Samples of the same showing, the slaty cleavage transverse to the bedding. The dip of the slate beds is to the S. W., amounting to about four degrees, the conglomerate being unconformable.

452. Slate pencils, formed naturally by the intersection of diffierent divisional planes, having a rhomboidal section. The overlying coarse, gray conglomerate, seems to have a thickneess of about 100 feet. Above that is a considerable red, finer conglomerate, perhaps fifty feet.

453. Slate from the lower falls of the St. Louis river, S. E. ¼ Sec. 10, T. 48, 16.

454. Near the foot of the falls, on the left bank, are several "veins," or folia of white quartz, parallel with the slates, some of which are four to six inches in thickness. They are all in an interval of about three feet, with folia of slate between.

455. Slate embraced between and contiguous to the white quartz.

456. Harsh, arenaceous, gray, firm beds, two to three feet thick, embraced in the slate at the lower falls, having no slatiness.

457. Slate; average sample for the rock of the lower falls.

The cause of the lower falls is the occurrence of a dyke of igneous rock which crosses the falls near their brink, hardening the layers of the formation. The falls cross the river stragglingly about east and west in conformity with the strike of the formation, and descend about twenty-two feet in the distance of about six rods, but the water is rapidly descending in other short cascades for a quarter of a mile above the falls. Also below the falls it continues as a rapid to the foot of the islands, descending about fifteen feet more. The dip, which is taken to be the general incline of the heavy beds toward the S. E., is 63°, but there is a multiplicity of folia, joints and seams, and sedimentary planes, that all confuse the question of the dip. This measurement was made near the dyke, and on the east side of the river.

458. Hardened slate formation, contiguous to the dyke at the lower falls. The slate here has a coarsely basaltic structure along the east

e that the conglomerate lies in depres-
s thicker in some places than in others.
ot visible, but there cannot be much
side. So that, as already stated, there
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arsely basaltic structure along the east

side of the dyke. The columns run
degrees from the horizon.

459. The doleryte dyke at the low
E. and is at least twenty feet wide. It
high stage of water prevented a full v
has so hardened the slates that they a
of the river than the dyke itself.

460. Above the falls, nearly oppo
being numbered up stream,) two other
the rock being of the same kind as
grained. One seems to be about eigh
feet wide.

461. Sample from the eight-foot dy

Above the lower falls, along the e
rock stands up in the channel as very
ing about twelve feet near the lower e
upper end of the island. The fall ne
No. 5, is due to the occurrence of a ra
slate immediately below (i. e., down s
part having been torn out faster tha
island, east of the upper end of Island
is 27° S. E.

There may be other dykes, not visi
the river under water entirely and ent
hid by drift-wood or by standing tre
wears away faster than the formation

The rapids below all the islands (
These rapids continue on between th
which is on Sec 10, at the head of Isl
ting the fall into two parts, the greate
island. Six or eight rods below the f
island. Island No. 1 begins still fur
the section line between 10 and 15.
having but three large pine trees, (t
seems to consist of boulders, and rises
water. Island No. 2 rises twenty feet
covered with pine, with a few birches
(227 feet,) causes the current here to tu
uniting with that which passes down
Just above Island No. 6* is the wilde

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*The islands number 6 instead of 5. They are wrongly
also a number of rock islands.

of the river, where it comes ne
scent here, in about a quarter
is no regular fall, but a rushi
to side of the channel, cut a
highly dipping slate, which
that alternate with sharp a
which sometimes rises in t
feet, and is very conspicuo
eight degrees to the S. and
and the latter to the S. S.
dicular all the time. The
of fifteen to twenty-four
which is in layers of a f
show a finer bedding if fa

The roar of this river h
and it seems equal to that
distance that the multitud
pheric commotion as the
and to be comparable to
be heard for sveral mile
train on the railroad, for
comes with the changing

462. Fine-grained dy
mouth of the creek comi
above the foregoing rou
visible only on the shore
It is about thirty feet w

463. Rock similar t
N., about 15° E.. on N
the river.

464. From a dyke c
in the same direction,

About thirty feet a
about six feet wide, b
north bank. It show
is situated about ten
the S. E. ¼ of Sec. 9,
uncertain character.

At the island on
rough as it separates
slate is nearly in the

ly along the strike of the slate. The de-
a mile, must be about forty feet. There
; and foaming torrent, dashing from side
parted by the jagged protrusions of the
its variations of hardness forms troughs
angular ridges. The dip of the slate,
middle of the river twelve or eighteen
disposed, varies from thirty to forty-
e S. S. E. The former dip is to the S.
he slaty cleavage being nearly perpen-
nd bedding of the slate is in thicknesses
es, but there is also a thinner bedding
ches. Perhaps the heavier beds would
bly weathered.
greater than that of St. Anthony Falls,
iagara. It is continued over so long a
s dashing seems to make as much atmos-
e plunge of a large stream at Niagara,
oar of an extended beach-line. It can
l is like the rumble of a heavy freight
n it is apt to be mistaken at first, as it
ents of wind or is echoed on the bluffs.
k, from a dyke crossing the river at the
om the north on S. W. ¼ Sec. 10. It is
d jagged portion of the river channel,
s less durable than the hardened slate.

st, from a dyke eight feet wide running
of the S. E. ¼ Sec. 9, T. 48, 16, crossing

the river a short distance above the last
ty feet wide.
last appears to be another narrow dyke
rtain pieces *in place* can be seen on the
rge in the slate on the south bank. It
w the small island in the river seen on
ut five rods above is another of the same

¼ of Sec. 9, T. 48, 16, the river is very
ges among the rocks. The strike of the
of the river. The island itself is made

of a knob of hardened slate, with a f
a strike on each side of it stand up in
and cause the water to twirl along o
when it leaps over, or rises and falls o
and runs into another trough from w
This takes place on each side of the
esting and beautiful near the head
Below the island, in the main chann
as it makes its way through other tro
is divided into several such trough
embraced in one rapid chute about
the sides of which there is a boiling
central current plunges and foams d
thing in the State that surpasses
river. Norwood says the upper falls
do not see how they can exceed thes
quarters of a mile the river is more
and impassable even for canoes, wit
shore and in the channel.

Just at the head of the island, and
esting irregularity in the layers of th
zontal, or rise gently from the wa
bend downward, and even dip sligh
then are suddenly deflected upward,
they again begin to dip into the river
to a large extent only apparent. Th
appearance being due to undulation
the strike, combined with a jointa
smooth planes sloping northward.

465. The slate formation from t
Sec. 9, T. 48, 16. Tough gray, firm
dency to slaty cleavage, finely arena

466. Siliceous slate, quartzyte, fro

Near the center of Sec. 8, is ano
river coming directly across the slate
striking E. and W. The beds her
swinging round to the S S.E., and be
highest dip is seen at the narrows, w
the heavy beds. At these falls the
though occasional similar layers of
with the slates at points lower down

ceous layers that require for the formation rather the design
quartzyte than a slate. Yet it is slaty, and breaks with the
easier than against it. The rock here is also accompanied wi
its of white quartz, which is like that seen at Little Falls, a
up like that. The quartz deposits are seen to be rather ve
foliations, though they follow nearly the direction of t
cleavage.

The strike of the slate hills in sections 9 to 4, (48, 16,) is
north, and the dip is from 46½ to 60° toward the south, and t
cleavage runs almost east and west.

467. Rock of the dyke at Thomson bridge.

468. Rock adjoining the dyke at Thomson bridge.

The river at the railroad bridge over the St. Louis is runni
course of a dyke of igneous rock, about twenty-five feet wid
being more jointed, and at the same time more easily rotted an
grated, has caused the gorge through which the river passes u
bridge. The walls on either side being of hardened quartzit
are much more durable. This dyke is visible in the bluff fa
bridge down stream, and the rock is coarse and gray, but it
hid by its own tumbling debris, while the slates stand up fi
sixty to seventy feet above the river. The dyke has a directio
E., but is some crooked.

There is an island, also of hardened slate and quartzyte, in th
visible from the bridge. This is due to the existence of anoth
ture in the formation which runs southwardly nearly to the
when it unites with the larger dyke; but just as it me
larger dyke, the intervening slates were so finely, and so entir
amorphosed, that the hardened mass has formed still anothe
(in very high water,) on which a pier of the foot-bridge rests.
is no evidence of this second smaller dyke except the gorge
hardened slate walls. This gorge that forms, with the larger
the two islands, continues northward a short distance in the
bank of the stream, but there is so much fallen drift and quart
it that no igneous rock can be seen. The dip of the formation
Half a mile northeast is a large dyke, sixty feet wide, which c
the river between Thomson and the railroad bridge. It run
angle of forty-six degrees with the strike of the slate and qu
hills, but it is much more easily destroyed than they.

469. From near Miller's Mill, north of Thomson, a quart
mile. This is from a bed of harder, non-slaty, gray quartzyte,
ing to the formation. It weathers nearly white from felds

for the formation rather the designation of a
Yet it is slaty, and breaks with the cleavage
The rock here is also accompanied with depos-
h is like that seen at Little Falls, and cracks
z deposits are seen to be rather veins than
follow nearly the direction of the slaty

hills in sections 9 to 4, (48, 16,) is east, 10°
n 46½ to 60° toward the south, and the slaty
t and west.
e at Thomson bridge.
the dyke at Thomson bridge.
ad bridge over the St. Louis is running in the
eous rock, about twenty-five feet wide. This
at the same time more easily rotted and disinte-
gorge through which the river passes under the
either side being of hardened quartzitic slate,
. This dyke is visible in the bluff facing the
d the rock is coarse and gray, but it is nearly
g debris, while the slates stand up firm from
ove the river. The dyke has a direction N. N.
l.
so of hardened slate and quartzyte, in the river,
This is due to the existence of another frac-
which runs southwardly nearly to the bridge
the larger dyke; but just as it meets the
ning slates were so finely, and so entirely met-
hardened mass has formed still another island
which a pier of the foot-bridge rests. There
second smaller dyke except the gorge and the
This gorge that forms, with the larger gorge,
nues northward a short distance in the north
t there is so much fallen drift and quartzyte in
can be seen. The dip of the formation is 46½°.
is a large dyke, sixty feet wide, which comes to
omson and the railroad bridge. It runs at an
rees with the strike of the slate and quartzyte
ore easily destroyed than they.
iller's Mill, north of Thomson, a quarter of a
bed of harder, non-slaty, gray quartzyte, belong-
n. It weathers nearly white from feldspathic

ingredients, and from the abunda
trachytes of the western territori
bed is eleven feet thick, and in s
slaty layers on each side of it. I
white quartz, some of which a
wedge out lenticularly, and diago
of quartz veins are in other pa
quartz deposits are quite freque
cleavage openings. The feldspa
is *faulted*, the east side being n
Nos. 310, and 418, and 505).

470. Slate, quarried for roofi
and of even, fine grain.

471. Slate like the last, from

472. White quartz, from a he
road bridge, where the county ro
It is embraced in the slate, and
on the side toward the river. It
cleavage. Near the top, the dep
but standing vertical it runs but
seen to run out, almost entirel
something like the roots of a to
crown. It is not coincident wit
joints, but stands perpendicular.
about ten rods. It is crossed b
hibited on the wall of a slate-rid
five feet higher. Along the rive
one large root runs below the w
and also another of six inches, b
within ten feet of the top. At t
seems to have been an anticlinal
and the opening produced by the
filled by quartz, some of it also c
standing in nearly a vertical p
of much displacement and crum
dent a dip toward the north. T
massive, but sometimes shows a
the slates. It is jointed, and d
which are distributed down the
stones for the quartz conglome
quartz contains galenite, pyrite a

473. Pyritiferous gray quartzyte (?); from the ridge along which the large quartz vein (472) is visible. The pyrite is scattered in perfect cubes, sometimes three-fourth inches across, and occasionally an inch, through the rock. The most of the cubes are about the size of peas. The rock is like No. 469, but finer, and has siderite as well as pyrite disseminated finely through the whole, the former becoming oxidized at the surface.

In some of the quartz veins which cross the strike diagonally, particularly in rock 469, and 473, which veins die out and are replaced by others a little further to the right or left, lenticularly, the white quartz has been intercrystalized with siderite, which on weathering changes to hæmatite, and then washes out if wholly free to the air, leaving a gashed appearance among the quartz crystals when exposed. On deep fracture, when not thus exposed, the siderite is preserved—and in other places can be seen passing into hæmatite.

474. Dyke rock, near the Northern Pacific Junction. This dyke is thirty feet wide. The average dip of the slate formation in S. W. ¼ Sec. 6, T. 48, 16, is 57 deg. to the S. 5 deg. E. West of dyke rock, No. 474, which is a little east of Paine's saw mill, are other dykes, parallel to 474, one being still nearer the mill, on the east side, and one west of the mill. They all run about N. 5 deg. E. (compass), with a slight variation a little east or west of that, and they all consist essentially of the same kind of rock—a greenish gray doleryte. In both respects they are like those seen crossing the river below Thomson.

475. Doleryte from the most westerly of the above mentioned dykes—one of the triclinic feldspars appears porphyritically in this, which is not common in the rock of these dykes.

Up Otter Creek, two or three miles west of the Junction, there is said to be a large exposure of rock, like that at the Junction. It seems then to continue on to Moose lake, where it is again seen thirty miles south of the Junction, and causes a rough and more elevated tract of country. On the road to Twin lakes, about a mile south of the Junction, there are three or four ridges of slate.

Northward from the Junction, along the Knife Falls railroad, a number of cuts in the rock display its character and position. Cut No. 1 is about three-fourths mile from the Junction and is in slate that dips south at about the usual angle. There is a little ridge further north, and on the west side, that has a much higher dip to the south—about seventy-five degrees. Cut No. 2, which is nearly a mile further north is in a hard, gray, massive quartzyte, which has joints running in various directions, and shows no dip, but in a small slate outcrop along its northern side there is sign of sedimentation dipping about 45 deg. S. (as usual.) The same dip can be seen in a parallel slate range on the west of the road nearly opposite this cut. This quartzyte range is high, long and conspicuous toward the east, but to the west it soon ceases. The slate range on the west also is short, and the surface settles down to a valley in which there is a stream, with a high timbered plateau on the north side.

Cut No. 3, about two miles north of the Junction, is near this high land, but the road bends east at the cut so as not to go directly toward it. (See No. 505.) North and west of the Junction are numerous slate ridges which are not struck by the railroad.

The river below Thomson is filled with rapids and falls all the way to "Bridge No. 5." There are four spots, in particular, where there is valuable water power:—first, near bridge No. 5, where the river in a short space is divided into various channels, by six islands that occur between its banks. Three of these islands are above the fall and three are below, but there is also a considerable fall above island No. 3, (numbering from below) extending to near the head of island No. 6. This whole fall is fifty-five feet. The existence of the islands and the widening of the river, as well as the extent through which the fall is carried before it reaches rather quiet water again, are favorable for the improvement of this power, and its utilization. But a short distance above the head of island No. 6, is the second fall, where the river is narrow, but has the rock formation of the country in conspicuous strike along each bank confining the water like artificial dykes, within troughs which run somewhat obliquely across the course of the river, and rising in knobs and rough islands (with constant dip toward the S. E.) in the midst of the river itself, sometimes eighteen or twenty feet. This condition of the river extends from near the bead of island No. 6 to the dyke (No. 462 above), which is near the mouth of the creek that crosses the railroad on the N. W. ¼ of Sec. 10, and the fall here, which may be called cascade No. 2, amounts to sixty-five feet. There is then a gradual ascent of twenty-five feet among the rocks to the foot of the fall at island No. 7, and of twenty-five feet more in getting round the island itself, where the river is divided and beautified by the disposition of the slate ranges as already described under No. 464. This is cascade No. 3. Above this the river is more steady in descent for one-half mile, when there is a widening of the channel near the mouth of a little creek from the north, and a fall of about six feet over one of the harder beds that protrudes above the rest. This goes diagonally across the stream. There is then a similarity in the stream to and beyond the "retaining wall" of the railroad, a distance of nearly a mile, through which there is actually a steady ascent, amounting in the aggregate, from the head of cascade No. 3 to the foot of the Thomson Fall, to seventy feet The Thomson Fall is regarded as beginning near the 133d mile-post of the railroad, (near the center of Sec. 8) and extending to the large island on Secs. 5 and 6. That part of it below the mouth of Otter creek which joins the river near the railroad bridge south of the railroad, extending a distance of nearly a mile, is thirty feet, and is caused by the strike of the rock going directly across the river, causing it in several places to be suddenly contracted in width to twenty or twenty-five feet, through which narrow passages the river rushes with some fall and a swift current. The most of the fall is near the foot of the distance stated, but there is an irregular rapid and rocky river all the way up to the railroad bridge that cannot consistently be subdivided, though it is more rocky at and near the mouth of Otter creek. That part above the mouth of Otter creek, extending to the foot of the large island, is thirty-five feet. The greater part of this is near the foot of the island, but the river is a rushing torrent, in a rough narrow gorge, sometimes split by islands, all the way from the first fall to the creek. The total fall from the brink of Knife Falls to the water at the foot of the lowest falls, N. E. ¼ Sec. 15, T. 48, 16, by ameroid, is five hundred feet, with an estimated descent of fifty feet more to the level of Lake Superior.

476. Rock from near the river, south bank, about a mile above Knife Falls. The same formation, with the same dip and outward aspect occurs along here. It extends at least to the village of Cloquet, the direction of the slates being E. 10 deg. S. inclined to the south at an angle of 75 deg. or 80 deg. Along the river are occasional low slate exposures. The islands are caused by low slate elevations.

477. From the same place as the last; coarser, similar to that near Miller's Mill. (No. 469)

These rocks are in some places cut by slaty cleavage. They are rather firm, but have a *grain* running in the line of the slaty cleavage (476), but in other places (477), it is not affected by cleavage, but is cut by joints running in all directions across it, so that there is a semblance to dip toward both the south and north. The slaty cleavage goes diagonally across the jointage systems. After a careful study the dip is made out satisfactorily to be toward the south. Between this place and the Indian Reservation, which is a mile above "Pose's," the country is covered with drift, and timbered heavily. At Pose's the bank is about one hundred feet high, and apparently consists wholly of drift. Usually there is a belt of swampy, clayey alluvium between the drift banks and the river, about six feet above the present stage of the water. The river is very quiet above Pose's to the little island known as *Pine Island*, three miles above, where there is a fall of about eight feet in a tumbling rapid, the most of the descent being below the island. No rock in place is visible at the island—only boulders, of many varieties, chiefly like the Rice Point rock at Duluth. The island has a covering of tall pine trees. The country is not hilly, only moderately undulating, with considerable good pine. The long, narrow island at Pose's is low and not rocky, or stony, even, but sandy and clayey. The lower islands are rocky.

478 Represents the last rock on the right bank of the St. Louis above Knife Falls. This is found on the south bank nearly opposite the foot of the island known as Homestead Island, very near the same place as No. 477 and 476, but further west This is firm, gray, crystalline, with translucent grains as if of quartz, also having rusty specks when weathered, as if from oxidized siderite or pyrite. This, under the microscope shows in thin sections that it is one of the arenaceous members of the formation. This is an important rock-horizon. It seems to run further east, and also to extend under the river, forming the islands—at least such layers occur in the strike of the islands, and also form the brink of Knife Falls. It varies a little, becoming more like the rock at Miller's Mill, (469), than 478 is.

This is supposed to be Norwood's "last rock," which he styled an igneous rock, or doleryte, (his No. 454), having a direction nearly north and south, crossing the river nearly at right angles. This rock has translucent grains (which may be his supposed nepheline) but it is certainly a part of the formation and strikes east and west.

479. Rock from the brink of Knife Falls, similar to No. 477, a gray quartzyte.

480 From the brink of Knife Falls, finely crystalline, with minute grains of quartz visible in thin section. There are places in the formation where there is a change in the crystalline character, a greater frequency of joints, a finer grain, a loss of cleavage, and other features that accompany the metamorphosing proximity of a dyke, but where no dyke-rock can be seen. This sample seems to be from such a place.

At Knife Falls the descent is fifteen feet altogether, and about six feet perpendicular.

On the island first above Knife Falls the dip is N. 25 deg., forming an angle with the slaty cleavage which dips S. about 85 deg., and frequent joints cut the strata. The rock at this point is slaty in the direction stated, but the real slatiness does not appear as soon as a coarser slaty lamination which, on the surfaces of opened jointage planes, is in layers about one and one-fourth inch thick and looks like a bedding of sedimentation dipping almost or quite parallel with the slaty cleavage.

481. Slate, from the point above described. The piece has the lines of supposed sedimentation crossing the slaty cleavage as noted.

Just below the point of the last observation, which is where a small channel crosses the island in time of high water, is a nice little fall of about five feet, in the channel on the north side of the island, the channel itself being about twenty feet across. This rock is firmer than the rest of the formation here, and consists of alternations of argillaceous slate with a slaty cleavage, and a gray quartzyte. This quartzyte has translucent grains like the rock of 479. Here the dip is plainly 48 deg. S. 3 deg. E., the alternating quartzyte and slaty layers being a sure indication of *what* the dip is. This observation negatives the last note in regard to dip, the structure there supposed to be dip (illustrated by No. 481), being due to a former slaty cleavage, or to a foliation, or to a striation produced by friction, or to what? The water crosses the strike at an angle of about 45 deg., where it passes over these beds. There are ten beds of argillaceous slate that do not (with one exception of a bed of about three feet) exceed eighteen inches in thickness, some being but about six inches, alternating with hard and gray quartzyte layers which have a little greater average thickness. These layers strike to the north of the main falls in the south channel, and appear on the east end of the island below the falls. The slate beds have a perpendicular slaty cleavage, but the quartzyte beds have no cleavage of that kind, but are variously jointed. The slaty cleavage gradually fades out in the quartzyte beds, firmly cementing them with the slaty beds. Many of the joints of the quartzyte pass through the slate beds, particularly those that run at right angles to the strike.

482. From the above slaty layers.

483. From the above quartzyte layers.

484. Samples showing intermediate characters.

At the real Knife Falls, which are on the N. W. ¼ of the S. W. ¼ Sec. 13, T. 49, 17, and face toward the north, the brink running exactly east and west, the dip is 48 deg. toward the south, and the rock consists of alternations of slaty layers with gray quartzyte, exactly as ast described for mumbers 482-3-4. But there are here two very prominent and persistent beds of the gray quartzyte, one of which forms the brink of the falls, while the other is forty feet below the falls, and lies immediately over the section of beds represented by Nos. 482-3-4, or is separated from them by an interval of twenty or twenty-five feet occupied by the same sorts of rocks as those. This lower quartzyte bed forms a spit of jointed rock that projects eastward just below the falls. Along the banks, both on the island at the west end of the falls, and on the main at the east end, immediately below the falls, there are heavy beds of gray quartzyte which seem to be as durable as the rock in the brink of the fall, but they have not resisted the water so well as those further down, just mentioned. They rise, however, higher in the banks, especially at the east end. The rock over which the water plunges has a basaltiform jointed structure about at right angles to the dip, but no characters of undoubted igneous rock can be seen, nor evidence of igneous action in the form of dyke-rock. Yet, just at the west end, even west of the little island that is in the fall and cuts it into two parts (the little island and the west channel make about one-third of the whole)—there near the west end of the little channel the rock is closely jointed in a direction N. and S. (or nearly) and hardened, becoming fine-grained, these characters also striking the spit running east from the main channel. This dyke-like appearance has a width of about four feet, and although it is in a low spot across the spit where sometimes water flows in a high stage of the river, yet it forms a little island in the rocky channel just in the brink of the falls.

485. Is from this fine-grained rock which has the manner of a dyke, though it does not show the mineral characters of the dykes that cross the formation. This belt runs N. and S. as above described. In thin section this rock proves to be granular and finely arenaceous, and hence a part of the country formation.

486. From the quartzyte spit below the falls.

487. Slaty alternations in the spit below Knife Falls.

488. Gray quartzyte, similar to 478 and 469.

This is from the north channel, from near the lower end of the third island (not counting the little island in the brink of the falls) and is north of that called Homestead Island. The rapids are twenty rods above its first exposure, which is much greater than on the south shore where 478 was obtained. These heavy, gray quartzyte beds, although they differ widely from the most of the formation, having a massive and jointed outward aspect, and thus resemble the dykes of true igneous rock, have not the composition of the dolerytes. Further, they run E. and W. instead of N. and S., and are interbedded with slaty layers. They could not be mistaken for dykes wherever their stratigraphic relations are visible. In this place no other rock can be seen. It extends along the shore about thirty rods (E. and W.) and does not vary. The main jointage system runs N. 3 deg. E. The rock gradually disappears among boulders some of which are very large, and yet seem to be like the same rock. They show, however, a little *grain*, or schistose structure, approaching that seen in some of the slaty beds of the formation.

489. Samples from one of these large boulders that seem to show a gradation toward the slaty beds. In rock 488 are veins of white quartz some being five inches thick.

About fifty rods further up the north channel is a cross-channel, between two islands, the water running north; opposite which, and immediately below, in the middle channel, are seen other rapids and much rock in place. The surveyors' plat of the river about Knife Falls is quite faulty. The islands are all represented as one, and the river seems to have but two channels instead of three. This rock shows a slaty cleavage running E. and W., which has a dip to the north, or is nearly perpendicular. It belongs to the formation of the country. South of this rock exposure, which forms a rapid place crossing the middle channel diagonally, is Homestead Island, or island No. 5. The rock is very like that forming the falls, but probably lies below it, as it is a little further north. In these rapids is a little rocky island, rising about eight or ten feet above the river, having three or four growing pines and cedars. These rapids are higher up the river than Norwood's "last rock."

490. An arenaceous, somewhat slaty, hard, gray rock, from the rapids in the middle channel, north of island No. 5, near Knife Falls.

491. From near the same place as No. 490, and related to it in position, in the same manner as the spit of hard rock below the falls is to the rock in the brink of the falls, *i. e.* in a conspicuous strike parallel and thirty or forty feet further north; a firm gray quartzyte.

492. Doleryte, from large boulders at the rapids at the head of island No. 4, scattered about as if from a large dyke in place near, but cannot be seen in place.

493. Gray quartzyte from boulders apparently derived from the rock in place near. The rock of the formation is in place at this point.

494. Rock from one of the firmer beds of the formation about one-half mile below Knife Falls, at the river bank.

Below Knife Falls in the first quarter of a mile there is a descent by rapids, of about twenty feet. The river then turns SE. The water is still rapid, and has a broken cascade over boulders at one-half mile, with a fall of about three feet. The rock is exposed constantly from

Knife Falls, the precipitous walls rising, at the cascade just mentioned, to the hight of twenty-five feet.

At a quarter of a mile below this is a fall of about seventeen feet in three hundred feet, there being no perpendicular fall. There is a division of the stream into four channels by the strike of five different persistent beds in the formation, the water running in the strike of the intervening beds, the hard beds forming islands in the falls. The width of the river at the brink is about two hundred and thirty feet, and a dyke of about two hundred feet crosses the river just at the head of the fall. This dyke is destroyed by the river faster than the rock itself, owing to its frequent jointage; and the most rapid descent of the water is over the hardened beds of the formation on the east side of the dyke.

495. Rock from the two hundred feet dyke at the falls above men, tioned. This dyke runs N. 5 deg. E., and is of a firm and fine grain though principally feldspathic. The dyke is finely jointed and easily shattered by the frost. The dip of the formation is S. 60 deg.

About one-fourth mile below this fall the river turns about south, so as to go directly against the strike of the rocks. The banks increase in height, the dip increases in degree, and at three-fourths of a mile further, there is a high rocky island (Fortress Island) from the foot of which a portage trail sets out to Knife Falls, on the west side of the river. The larger part of the stream passes on the left of the island, the descent being eight feet over large boulders. At this place the rock of the country is wholly slaty; and although a short distance above the island there is a gradual change in dip from 60 to 70 deg., and then to 90 deg., as the river exposes the beds, yet in viewing the island from the N. W. down stream, there is, besides the slaty cleavage, a coarse bedding or jointage system visible on the east side of the island that seems to dip about 45 deg. S. E. At a distance the island itself, in its perpendicular walls, covered with a red lichen, cut by joints that cause the slates to fall away in masses, looks like a basaltic island of igneous rock. But there is no igneous rock in it. It rises fifty or fifty-five feet above the water, and is covered by small pines, among which are many Norways. The actual bedding either coincides with the slaty cleavage or dips S. E. at about 45 deg. This is an interesting spot. The appearance of the island reminds one of basaltic Staffa, but of course its structure does not illustrate that. The banks of the river are not so high as the island, but on the east side the rock rises fully as high a short distance back. Below the island the valley is deep and has high, slaty walls, the water being steady for at least half a mile.

The portage trail which sets out here, going west, is that traveled by Norwood, and by the explorers and geologists that preceded him. Duluth was probably the first white man that passed over it. It leads to the Mississippi and to Vermilion lake. Douglass Houghton traveled it with Schoolcraft, and with Lewis Cass. It was the outlet for the immense fur-traffic of the Upper Mississippi region. The name "Knife Portage," by which it is usually known, is well applied, because where it starts, and for some distance, the slates are thin, perpendicular and sharp like knives.

496. The rock of the country, from the beds *in situ* at the head of the uppermost of the chain islands above Knife Falls, (same as 493.) This was got by Mr. Terry on making a re-examination of the rapids. He reported no dyke in place there.

497. From near the middle of the central channel, a short distance above the head of the uppermost chain island, gray quartzyte, (Terry.)

Mr. Terry also found similar rock in place near the head of Homestead Island, but a little on the north side, in the central channel, which seems to be really the "last rock" to be found in the St. Louis, until reaching its higher tributaries.

498. The rock of the country from one hundred and fifty yards above the fall where 495 was obtained. (Weitbrecht.)

499. Rock immediately overlying 498. (Weitbrecht.)

500. Slate from just below the falls described under No 494. (Weitbrecht.)

501. Dolerýte dyke-rock, center of Sec. 19, 49, 16, right bank of the river.

Below Fortress Island, where the first little rapid is seen, a dyke crosses the river about N. and S. It is forty or fifty feet wide, and is best exposed in the right bank some rods below the rapids. It is represented by No. 501 This dyke appears again thirty rods further down, and can be traced for half a mile along the right bank, to and beyond the floodwood. The direction of this dyke carries it across the railroad, near Paine's mile at N. P. Junction.

The river is then tolerably slow to and beyond the cluster of small islands just below the floodwood (hence named *Floodwood Islands.*) The floodwood now is a floating jam, in length about the same as the width of the river, six hundred feet, with a few alders on it, and is wholly above the islands, the lower end of it being about 1,200 feet above the islands. There is, however, a considerable other floodwood lodged about the islands and sunken between them.

The river is then slow and broad down to three other islands (not represented on the surveyors' charts) below which it again soon descends over rapids caused by boulders, about two feet. Here the river is broad and shallow. Then appear two islands represented in the S. W. ¼ Sec. 30. Between the larger of these and the right bank of the river is another rapid descent about three feet, over boulders. The rock of the country, however, closely underlies, as shown by an outcrop a few rods west of the right bank.

At about a mile above "Cut No. 3" (N) on the grade of the Knife Falls railroad, mentioned under No 475, a creek crosses the new grade. At this place there is a cut in the rock on each side of the bridge. That on the south side is short and about four feet high, while that on the north side is about nine feet high, and extends about one hundred and twenty feet. In the south cut the slaty cleavage dips to the south, but is nearly perpendicular. In the north cut it is also nearly perpendicular but dips to the north. The sedimentary bedding is not discerned. There are belts of lumpy, white vesicular quartz, coincident with the slaty cleavage, which lenticular lumps are surrounded by a greenish slippery coating that often appears slickensided. These belts are sometimes wholly of quartz, and are continuous for some feet, and reach five or six inches in thickness. They seem to be the result of foliation coincident with the direction of the original sedimentation.

At the next cut which is about one-fourth mile further north, the depth is five feet, and the slaty cleavage dips slightly to the north. The cut extends about four and one-half rods. The rock is wholly slaty, and no sedimentary structure is observable unless it coincides with the slaty cleavage.

The road runs over water-worn boulders, with much corduroy, with no soil, nearly to the creek mentioned Then there is a filling, then occasional fills and shallow cuts in a little stony loam, with large boulders, the country being clothed with swampy varieties of trees.

Just beyond the point where the road strikes the drift bluffs of the river, another cut in slate-rock appears, the cleavage dipping north, as before, and including conformable layers or folia of white quartz, in varying quantities This is a firm slate, suitable for roofing, like much of it throughout the country. A short distance further are two small cuts in slate. In the northern one the slaty cleavage is different in different parts contiguous. The most of it dips toward the north, at an angle of about 45 deg., but in the midst of it are two belts that run from the top to the bottom of the cut, in which the dip is about 80 deg. toward the north. This cut is thirty feet long and six feet high. Further N. W. the road runs on a dirt fill on the slate ranges about a quarter of a mile. The rock can be seen and shows heavy bedding dipping toward the south about 45 deg., the slaty cleavage crossing the bedding with a dip of about the same amount in the opposite direction, the cleavage showing a *twist* out of the normal direction as it passes the joints from bed to bed. The whole aspect of these ridges is light-green.

At half a mile further is a long cut in greenish slates, perpendicular, or at the north end slightly dipping to the north, and at one-eighth mile further another small cut having the same features. Two more small ones appear before reaching a dyke which exposes a width at least of thirty feet. It appears on the N. E. side of the road and runs apparently, E. N. E. It is cut by the grade to the depth of about three feet, with a slate cut immediately south east of it. At half a mile further another dyke ot similar character is seen near the Knife Falls. It is in place by the N. E. side of the grade, and was slightly cut in the grading. Its width and direction cannot easily be seen owing to the forest.

502. Gray doleryte, like No. 501, from the dyke last mentioned. One other cut in slate appears beyond the dyke about a quarter of a mile, but showing only on the north side, though frequent ranges of slate appear along the grade on both sides, rising six or ten feet.

503. Gray doleryte from the E. N. E. dyke before mentioned, apparently the same as No. 502.

504. Gray quartzyte holding slate-pebbles, as if conglomeritic, about two and one-half miles from the Junction on the grade of the railroad, situated between the "Cut No. 3" and the creek mentioned after No. 501. This quartzyte hardly has any cleavage, but shows a lamination in laminae about an inch thick, which indistinctly appear on shattering the rock by blasting. These have a high angle of dip toward the north, across the bedding, which dips south at about the same angle; and they are probably the product in this quartzyte of the same operation that caused the slaty cleavage in the slates. Although styled quartzyte, here as well as in other places, this rock also contains a large ingerdient of feldspar which in No. 504 is partly orthoclose. In others, the feldspar has been seen to be, at least in part, a striated feldspar. The slaty pebbles in this rock are rounded, and are often half an inch in diameter, and occasionally are two inches long.

They are fine-grained, and resemble the slippery coating that surrounds the quartz deposits mentioned under No. 501.

505. At the long "cut No. 3," mentioned under No. 475, there are several interesting features exhibited by the strata of the formation. This is nearly two miles north of the N. P. Junction.

1st. In the north end of the cut the slaty cleavage dips north about 80 deg., and in the south end it is nearly perpendicular.

2nd. In the southern portion of the cut is a change in the formation from slate to a gray arenaceous rock like Nos. 469, 478, 488, 491, 493, 497 and 504, though it is not conglomeritic like the last; and the slaty cleavage on both sides of this rock is conformable with its surfaces. This rock is represented by No. 505. It has somewhat the outward appearance of a dyke of igneous rock crossing the road in a zigzag course E 5 deg. N. It weathers nearly white and has a width of twenty-seven paces.

3rd. This rock, (505) has no slaty cleavage, but a coarse jointing. The slate beds on the north side dip N. and on the south side they are about perpendicular.

4th. On the east of the road, one-fourth mile distant, is a high hill of rock of this kind, and near the north end, on the west side, the ridges show a twisting in their strike, or a quaquaversal throw, so that the E. and W. slaty cleavage crosses them diagonally, the ridges bearing S. E. and N. W.

5th. Hence the slaty cleavage came after the tilting of the formation, and keeps its E. and W. course whatever the direction or amount of the dip.

6th. The hill of this rock, above mentioned, is east of the road less than one-fourth mile. It is an isolated knob rising about twenty-five feet above all the other ridges. It is about circular and five rods over, with a broad rounded top. It seems to be a sudden augmentation of No. 505 among the slates, and its connection with No. 505 in cut No. 3, can be traced connectedly. The course of 505 is about toward the rapid in the St. Louis, three quarters of a mile above the Big Island in the river near Thomson.

506. Large sample of slate, showing the slaty cleavage crossing the sedimentation, from one mile north of N. P. Junction, Knife Falls railroad.

Along the east side of the Big Island near Thomson, the ranges cross the river, causing rapids, and a descent of about ten feet in twenty rods, the most of it being in the lower ten rods. The river here runs against the strike, and the channel is narrowed as below

Thomson suddenly, to about thirty feet. The rock dips 45 deg. N. and stands up conspicuously along both sides of the channel, the slaty cleavage dipping 45 deg. to the south. There is then comparatively still water to about the middle of Sec. 31, (south of it a little), where the rock again causes rapids and a descent of six or eight feet.

507. Gray, slaty quartzyte, "just across the north channel at the head of the second rapids, on Homestead Island." (Terry.)

508. At the extreme upper end of Homestead Island, at the very point, higher up than any rock along there before mentioned; a gray quartzyte, with visible grains of quartz. (Terry.)

509. Some rods east of the head of Homestead Island, on the north side, about one hundred rods west of the head of the rapids that there run across to the other islands; a gray quartzyte. (Terry.)

510. Slate from the very foot of Homestead Island, below the rapids last mentioned. (Terry.)

The Chain islands, here so designated, are often known as Green Islands, from the man who preempted them. The "Grand Rapids," of the St. Louis begin one-half mile above Pine Island, and continue five or six miles. The water then is comparatively quiet to the mouth of the Cloquet. Just below its mouth is a large rapid. (Mallmann.)

*Downward section of the red sand rock and shales at Fond dn Lac.**

1. (443.) Red sand rock, quarried at Fond du Lac. This begins above the level of the railroad grade and extends downward through a thickness of (estimated).................................... 50 ft.
2. Dark red shale.................................... 18 ft.
3. Shaly sand rock, less firm and siliceous than No. 1, (changes gradually to the next).................................... 12 ft.
4. Red shale, with some sandy beds.................................... 30 ft.

Ascending the river, here it turns south, and as the dip is to the S. or S. E. the sand rock No. 1 is brought again into sight in the banks of the river at the extremity of the point, and in the opposite bank of the river. This is about one-half mile west of the state line. No. 4 again occupies the low river bank (north bank) above the point, after it turns west again, for ten or fifteen rods. It has some beds of light color, a few inches thick, such lighter colored beds being coarser. After a short distance of no visible rock, the underlying beds appear, viz.:

	Ft.	In.
5. Fine conglomerate light....................................		6
6. Red fissile shale....................................		8

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* Also see Nos. 443 to 449.

7.	Light colored coarse sandrock, or fine conglomerate..		8
8.	Red fissile shale..............................	4	6
9.	Fine conglomerate (light)........................		5
10.	Fissile red shale............................	3	
11.	Fine conglomerate (light)..........................	3	
12.	Fissile shale, with green spots, some beds ripple-marked....................................	14	
13.	Fine conglomerate..............................		8
14.	Fissile shale....		3
15.	Fine conglomerate.............................	2	
16.	Fissile shale.................................		3
17.	Fine conglomerate..............................		4
18.	Fissile shale................................		4
19.	Fine conglomerate.............................	1	
20.	Fissile shale...	3	6
21.	Fine conglomerate	1	6
22.	Shale and shaly sandrock, with layers of light green, seen	14	

The bluff here is about twenty-two feet, (of exposed rock) for about thirty-five rods, below the creek that comes under "Bridge No. 1," and for about ten rods above, the opposite bank having no exposure.

		Ft.	In.
23.	Light red sandstone..............................	3	
24	Fine red conglomerate.............................	4	6
25.	Shaly sandrock, red..............................	10	
26.	Fine red conglomerate............................	3	6
27.	Red shale and shaly sandstone; makes a dark band...	9	
28.	Lighter colored sandrock...........................	8	
29.	Green shale.....................................		6
30.	Red shale and shaly sandrock.....................	9	
31.	Fine conglomerate, with some thin layers of shale....	4	
32.	Sandrock, mottled and striped with cross-sedimentation....................................	5	

The mouth of the creek coming under Bridge No. 1, is on this sandrock.

33.	Fine conglomerate; the middle of this has pebbles an inch across, but is finer above and below........	7	
34.	Shaly sandrock, with specular specks, as if micaceous or hæmatitic. This extends but few feet, and pinches out into fine conglomerate..............		8
35.	Fine conglomerate.............................		10

36.	Fine shale		4
37.	Fine conglomerate	2	
38.	Shale		2
39.	Fine conglomerate, light-colored		6
40.	Sandstone, light-colored and red, with horizontal bedding; pinches out in fine conglomerate in twenty feet	1	2
41.	Fine red conglomerate with false bedding, passing below into a coarse, light-colored sandrock with false bedding	3	6
42.	Red, crumbling conglomerate, coarser below, with some pebbles of two inches	7	
43.	Shale, with green spots and some conglomerate	1	6
44.	Firmer, lighter colored conglomerate, inclosing beds of shaly sandrock which have cross-sedimentation.	3	
45.	Fine green and red shale		7
46.	Coarse shale	1	
47.	Fine red shale. Of this, but one foot can be seen at first; but as No. 44 strikes across the river forming a little rapid, and shows its place of beginning on the right bank, the section is easily continued on that bank. The stream here runs nearly at right angles to the strike, and a bluff rises about eighteen feet on the right bank consisting of Nos. 41, 42 and 43, or beds like them. Large blocks of No. 44 lie along the river, in the talus on the left bank. In these blocks are mainly pebbles of white quartz; then jasperoid and colored quartzytes; then arenaceous quartzyte of a red or pink color; then pieces of a greenish slate and rock like the Thomson slate rock. The pebbles are generally under an inch in size, and the surrounding material is also a fine conglomerate	15	
48.	Coarse, firm, light-colored pyritiferous conglomerate, sloping gradually into the water. This includes lenticular spots of shaly sandrock, and of red conglomerate. For some rods the upper surface of this conglomerate forms the low shore and is washed by high water, dipping into the river at an angle of 8 deg. It then stops abruptly by a fault, and the shore is occupied by a red and spot-		

ted green shale like 47, of which the dip is more to the south. Where the conglomerate is broken off it is highly pyritiferous, and cemented into a compact rock, and at the very fracture the whole is changed and vitrified, making a firm greenish quartzyte. In the bluffs on the opposite shore, (i. e. on the right bank,) may be seen four separate faults crossing the red shale andsand stone beds (apparently 41, 42 and 43,) from the top to the bottom. This is just opposite the point of faulting of the conglomerate on the left bank. After the abrupt disappearance of this conglomerate the left bank in ascending the stream is found to be occupied by a low exposure of layers of green and red shale belonging to some higher portion of the section, while the right bank opposite is a bluff with an average exposure of ten feet of rock, consisting of red shale and shaly rock, with varying dip. All at once the coarse conglomerate rises again, but not so suddenly as it disappeared, and forms the shore to the place where the slate formation is found underlying it unconformably. Where the conglomerate reappears it seems not to be faulted, but bent and somewhat broken upward, the shale-beds above also being somewhat bent and compressed, though maintaining a green color where in contact with the conglomerate. The change of level is about two feet, and it is expressed on the opposite shore in undulations in the strata. It is about forty rods above this point that the slates first appear under the conglomerate, estimated.. 50 ft.

49. Coarser conglomerate, containing about the same materials as the last, except the layers of sandrock. Dips S. E. or S. S. E. 7-10 deg. The white quartz pebbles are sometimes six or more inches in diameter. Some are of gray, or even a black jaspery quartzyte, and some are pieces of the underlying slate, showing the slate must have hardened as slate prior to the deposit of the conglomerate. On the oth-

er hand it is to be noticed that a roughly slaty manner of disintegration passes upward into the conglomerate from the slates where the weather has acted on the two at that horizon, the pebbles and cement falling off in slabs or lumps that are elongated in the direction of the slatiness of the slates and parallel with them, as if the cause that operated to produce the slatiness had taken effect since the deposition of the conglomerate, and had resulted in a similar structure in the overlying rock. In this conglomerate are pebbles of gray and black jaspery quartzyte which much resemble the great quartzyte of the boundary line, seen at Pigeon Point, and really can be referred to that formation. This seems to imply that that formation, which, with its jasper beds overlies the slates, should come in between the conglomerate and the slates, but for some reason is wanting here. The conglomerate at Grand Portage Bay may have that relation. (V. No. 254.) In some places a layer of green shale lies between the conglomerate and the slates. It is a foot thick. The coarse pebbly quartzose conglomerate has an estimated thickness of.. 100 ft.

The overlying finer conglomerate is often red.

Total observed thickness of the Potsdam at Fond du Lac is therefore.............................. 412 ft. 4 in.

By making a general trigonometrical calculation, with an average dip of 6 deg., and a hypothenuse one and one-half miles long, from Chamber's quarry to about half way between bridge No. 1 and No. 2, where the conglomerate begins, the thickness of the red sandrock and shale is found to be 883 feet. To this must be added the coarse conglomerate.

From Duluth to Silver Islet and Return.

511. At a point in the bed of Miller's Creek, just above the highway bridge near the ¼ section line of 32 T. 50, 14, 424 feet above Lake Superior, this sample was obtained. The rock, which is gabbro associated with fine red syenite, extends indefinitely up stream. It is jointed conspicuously N. W. and S. E. like a dyke. It is in some

places speckled finely with red feldspar, and in others it is crossed by veins of red feldspar, some being an inch in width and others very thin, somewhat resembling the rock at the old quarry of Maj. Newson at Duluth. Below the bridge is a rapid descent over rock of the same sort, in which the formation shows a coarse bedded structure, and dips E. at an angle of about 25 degrees. The left bank of the creek rises perpendicular about 23 feet, and the right slopes up gradually with the dip of the rock. The summit of the gap through the hill range is 607 feet above lake Superior. This is about a mile beyond the crossing of Miller's creek.

512. N. E. ¼ Sec. 25, T. 50, 15. Along the Herman town road occasional exposures are seen, rising above the rolling surface of gravelly red clay, of which this is a sample. It is a heavy, gray trappean rock with so much magnetite as to disturb the needle. Land of Peter Benson.

513. Rice Point gabbro, from a cropping on the N. W. ¼ N. E. ¼ Sec 27, T. 50, 15.

514. S. W. ¼ Sec. 22, T. 50, 15, (near the center of the quarter), land of John Mallmann. Here is an unusually magnetited bed of the rock of the country. It can be traced along about 200 feet, having a width of about 20 feet, as exposed, in low ground, bearing E. 10° N. It lies 5 rods to the north of another series of croppings of rock like No. 513. On the opposite side of a little creek, north of this number, is also a line of outcrop of rock like 513. No. 514 controls the needle entirely. It is dark, but specked with porphyritic crystals of labradorite. The center of Sec. 30, T. 50, 14, is the highest point in the hill-range, on the Herman town road, and is 747 feet above lake Superior.

Reviewing the rocks between Minnesota Point and Kinichigaquag creek one is compelled to the conclusion that they are mainly sedimentary; *i. e.*, in the sense that they were deposited in water and in that way received their stratified arrangement. They dip S. E. They also exhibit some of the characters of igneous rocks, viz.: their amygdaloidal structure, their color, their hardness, and an occasional wrinkled surface, that was formed by the fluid condition of the rock when flowing down an incline. The last characteristic particularly seems to prove that some of the beds were molten. On the other hand they show nearly all the characters of sedementation—parallel lamination, dipping in a constant, or nearly constant, direction, cross-stratification, variation of texture and color as well as mineral composition in the direction across the bedding. Whether they lie, stratgiraphic ally, above or below the sandrock at Fond du Lac is solely a matter of speculation, so far as the evidence here has any bearing.

There is a red sectile rock (Nos. 18, 19 and 30) that shows conspicuously along here, between Duluth and Chester Creek, which may have been driven by semi-fusion, and by igneous injection into the openings, &c., of the lower part of the igneous rock that forms Rice Point, and the hills back of Duluth. This is on the supposition that the Rice Point rock lies over the Chester Creek bed, and is in keeping with the fact that a red feldspathic rock occurs in patches in Duluth, and is in seams in the Rice Point rock at Newson's quarry. In that case the point of outflow of igneous rock was further to the northwest, and the lava ran over the broken beds toward the S. E. Before the full force of the igneous overflow is met in passing N. E. along the coast, the sedimentary beds occupy the coast except where, by dykes, or by interbedding, or by local outflows, the trap rock is found in its place. This indicates that during the period of deposition the igneous disturbances were going on, and that the semi-igneous nature of the beds may be due partly to the proximity of the igneous vents which would not only give an occasional flow of truly igneous rock, but would furnish a sediment quite different from an ordinary oceanic deposit. Ordinarily the sedimentary beds have a reddish color, but in the neighborhood of Chester Creek, and in Duluth some of them are greenish. The trap-rock seems to take a bluish green color along the shore. Occasionally a hardening of the sedimentary beds is produced so as to form a rounded point or promontory, or a sharp rocky point. Without such hardening the sedimentary beds usually are less durable than the trap-rock. In some cases, still, there is so close a mingling of igneous and sedimentary characters it is wholly impossible to decide, on the spot, whether a rock be igneous or not.

515. At Sucker river (V. No. 89). A fine-grained igneous rock, which crosses the mouth of the river. But it runs N. E. instead of N. 5° E.

516. Forms the bed of the stream, and appears like a bed of lava, being not jointed regularly, but smooth and massive, with pot-holes. This disintegrates into globules and rots to a great depth before falling away. It is heavy, dark green, and almost black when wet. In the stream are many pieces of prehnite-amygdaloid with a little native copper. These must have come down the stream from a belt which runs from French river southwesterly, back of Crystal Bay, and N. E. to Sucker river.

East of Stony Point, which is the east point of Sucker bay, the rock forming the immediate shore is an overflow of heavy dark trap which extends to Knife river; but within the bay east of Knife river are amygdaloids and purgatories for a mile and a half. Thin clay hides the rock, except occasionally, to the west point of Agate bay where begins about the same series of amygdaloids and non-amygdaloids as seen near Knife river, extending round the point and along the west side of Agate bay. Thus the rock from Stony Point to Agate Bay is all igneous. There is a similar alternation on the west side of Burlington Bay. (V. Nos. 94–102.)

517. Fine-grained trap, bedded, from the foot of the high bluff at the north of Gooseberry river. (V. 108.)

518. Trap-rock, top of the low bluff at the south end of the beach at Gooseberry river, containing amygdules of chalcedony. Furnishes some of the pebbles, and all of the agates of the Gooseberry beach. This rock slopes into the water, and where it is constantly under the action of the waves, and partly decayed, it is reddish, like the pebbles, but the pebbles mostly come from another bluff.

519. Agates, taken from the rock at Gooseberry river. At Gooseberry river is a high beach (25 ft.) of red gravel, extending from rock to rock (from 517 to 518), facing east, thrown up by the counter action of the current of the river against the easterly storms on the lake, which not only sweep the pebbles along the beach toward the west, but prevail with great violence in the spring and fall months. It is 300 paces long. In the red gravel of the beach are numerous chalcedonic agates, derived from the rock of the place. The bluff at the north end of the beach is about 75 feet high, and at the south end it is about 10 feet. In each case the rock slopes E. S. E. down to the lake, and below the water. They were once probably connected, forming a continuous sloping surface of trap-rock. The lower part of the bluff at the north end is bedded, and more jointed, but is fine-grained and firm. It is probably igneous, and seems to contain considerable chrysolite. The upper part contains chalcedonic amygdules, and is trappean. It decomposes in globuliferous parts, and is spotted by them before decay, the general color being a dark or bluish green. The whole bluff is trap and 75 feet thick. The beach is red with a few blue pebbles. The red gravel is finely amygdaloidal, and cannot come from the trap. The globuliferous decay is not noticeable in rock at the east of the bluff, near the water, perhaps because the erosion wears it away too fast.

The lower part of the high bluff at Gooseberry river, a short distance east of the river, is amygdaloidal with laumontite, and crumbles out faster than the overlying trap, causing the fall of large blocks from the top of the bluff.

The beds 517 and 518 occupy the coast exclusively (except one or two amygdaloidal beds,) with short intervals of red pebbly beach, to about one mile from Splitrock river, when a bluff rises from the water in a bay (No 110) and continues eastwardly. This bluff is the source of the red pebbles at Gooseberry beach. It is finely porphyritic with red feldspar, and seems also to have fine grains of calcite and quartz, as well as a few green amygdules. These, weathering out, produce a pitted water-worn exterior. The rock does not crumble, but goes to pieces in a multitude of small fragments which strew the beach and make the gravel. It greatly resembles the rock at Crystal bay (No. 78) and also the Palisade rock (Nos. 138 and 139), but is less firm than the latter. Its disintegration in angular bits in the bluff, by frequent divisional planes (not properly a jointage) is exactly like the Crystal Bay rock, but here it contains no large geodes of calcite, as there. It has the appearance somewhat of underlying the trap of Gooseberry river, but it actually overlies it.

520. Sample of the above rock, one mile west of Splitrock river.

520. A.—Sample of calcite-laumontite, from a vein in No. 520.

The westerly end of this bluff seems to show that it rises from under the rocks 517 and 518 with a strong dip toward the W. S. W. perhaps 40 degrees, but this westerly dip is not due to sedimentation tilted in that direction, but to a transverse jointage. It is so intimately jointed and angular that the original bedding, by which a deviation of dip is to be ascertained, is nearly obliterated.

521. Is an irregular thrust-up rock, appearing in the beach near the west end of 520. Its bedding is distorted. It almost appears conglomeritic, but the lumps and nodules that appear in it are due rather to crystalline aggregations, imperfectly formed. Some of its firm parts appear like the metamorphosed greenish quartzyte seen under the conglomerate near bridge No. 5 above Fond du Lac (V. after No. 510, in the *Section of the Red Sandrock at Fond du Lac* (Sub.-No. 48). But in the midst of this green are thin red (vitreous?) laminations that resemble in form, but not in color, the translucent streamed(?) interlaminations seen in No. 140. It is essentially a part of No. 520, but modified by some closely contiguous igneous agent. (V. 816).

Toward the east the bluff (520) shows horizontal bedding one, two and three inches thick, and the red rock passes inland among cedars, balsams and pines. At nearly the same point a lower trap-rock appears in the beach, being the same as that forming the little island opposite the bluff, 520, since it can be traced connectedly from the little island—by the shallow water—directly to the the foot of the red bluff. This lower trap holds a gray amygdaloid about 8 feet thick, and its lower beds run in the gravel beach, nearly to the Splitrock river, the chief exposure being just at the point, and 15 feet high (V. Nos. 111 A & 111 B). The red pebbles at once disappear, except that a few, mixed with the gray, are seen even at the mouth of the Splitrock, brought down the river and distributed westwardly. Where this lower trap appears in the little island it is agatiferous, at least has concretionary masses of quartz a foot or more in diameter, as well as other dark masses, 384 ft. in diameter. The geodic quartz cavities have few amethystine crystals. In this respect this trap bed seems to resemble the trap at the top of the bluffs at Gooseberry, instead of being another layer. In some places this is finely amygdaloidal, on the island, but generally heavy, compact, angular, and dark colored. These parts are irregularly mixed, and sometimes surround each other, as if in concretions, or as if one had been mixed in the other as a matrix.

Splitrock Point exhibits a novel and interesting geology. While the large feldspar mass seems to be in place, and to have furnished the smaller pieces embraced in basaltic trap toward the S. E. and E. it is highly probable that it is itself a transported mass. The oblique basaltiform structure of the trap shows it was molten and the feldspar was not. The feldspar is not basaltic, only coarsely jointed. This feldspar rock has a close resemblance to the Rice Point granite. It seems also to be older than the sandstone and conglomerate beds along here, and not to pass into the trap layers that are so conspicuous along the shore. There is a constant dip toward the S. W. in passing along here, and finally the feldspar rock seems to come to view as if lower than all. There is trap near the water, at the base on the east side. This continues, and shows oblique basaltic structure which slopes N. E. and a bedding that dips S. W. (V. 112 and 113.)

Immediately across a little bay east of Splitrock Point, and on the north side of the bay, at the foot of a high bluff (175 ft.) of Feldspar rock which stands a little inland, is an exposure of a dark-red, frequently jointed, rock. It is somewhat amygdaloidal, and especially near the top of the bluff, and seems to be a slightly altered condition of No. 520. It shows only a short distance (6 rods) and dips N. N. E. about 30°. It is darker red than No. 520 on fresh fracture, but the joints that give color to the bluff are lined with lighter red. It is probably also one of the shale beds of the formation, if not the lowest.

It is cut square off, and is immediately replaced by the obliquely basaltic trap (No. 524) which embraces masses of feldspar rock. Here the trap rises 50–75 feet above the talus of fallen pieces as the bluff extends east.

522. From the foregoing reddish-brown rock near its point of contact with the basaltic trap, near the top of the bluff, in the bay first north of Splitrock point. It here becomes darker, denser and firmer, and also amygdaloidal, bringing it to the characters of the rock that forms Two Harbors, the next point east. This seems to be another condition of 520, or beds like No. 520. In thin-sections it seems to be identical with the Two Harbor rock.

523. From the base of the same bluff. Similar rock, but more red. The Two Harbor rock is No. 117.

Just beyond Two Harbor Bay, (east) the relative superposition of Nos. 522 and 523, and their relation to the Two Harbor rock as well as to the Feldspar rock, can be seen. A feldspar bluff rises perpendicularly from the water about 125 feet. On the west of this bluff and in immediate contact with it, rises a basaltic trap bluff which is composed of the rocks.

524. Is a basaltic dark trap, 75 feet thick—underlain by 522, 523 and the Two Harbor rock, in the order named—the Two Harbor rock rising but little above the water. (V. No. 112).

Numbers 522 and 523 here show a sedimentary structure very evident, but it is in patches, and alternates irregularly with patches of laumontitic amygdaloid.

525. Sometimes a sandy sedimentary rock is in immediate contact with and surrounds patches of the amygdaloid. In the sandrock, which is of a light color, blotched with red, are impressions of fucoids. (V. No. 817).

On the east of this high Feldspar point there is a huge pudding stone of trap and feldspar for a short distance, and then under it a short exposure of No. 520 just as the bay begins. This last rises and runs inland, and the Two Harbor rock makes the immediate shore through the bay to the third high point, which is composed of a sudden upheaval of both the 520 and the Two Harbor rocks, the latter being basaltic and making the high point. (V. 119).

526. The knob of rock at the west side of Beaver Bay is of a crystalline red rock, feldspathic and firm. The green trap embracing the feldspar masses abuts suddenly upon it, from the west, and so ceases. This probably is the same rock as 119, and 520.

527. Sample showing the union and welding of the feldspar mas

at Beaver Bay with coarse trap inclosing it. It is not thus welded generally, so far as visible, but is loosened fron the trap.

528. Slaty, gray quartzyte, at the mouth of Beaver Bay creek. These samples are from the rock at the very mouth of the creek. It also runs back from the creek toward the west. Its abrupt and isolated outcrops will not permit any satisfactory identification of its horizon or its place in the shore series. (V. 127 and after 816).

529. (No. 1 to No. 6). Series of changes from trap rock to soil, Beaver Bay:

(1). Unchanged traprock, heavy and coarsely crystalline.
(2). Iron-shot and jointed trap-rock.
(3). Showing incipient decay.
(4). Crumbled trap-rock.
(5). Gravelly, earthy soil.
(6). Loam, soil and turf.

These are produced by the rotting of the trap-rock of the country, on the promontory where no other ingredient contributes to the soil.

530. Finer, dark trap, of the same general character as that which covers the country, but finer grained, magnetited, and perpendicularly basaltic, having a coarser grain in a dyke-like belt (2½ feet wide) running E. and W. This rock contains patches of red rock like No. 526 and within two rods, after a short interval not exposed, the rock No. 526 is seen in full force forming a bush-covered bank. The patches are as fragments or boulders, generally, but some patches do not appear like transported masses, but like dykes and veins. This is from the bay one-half mile west of the knob which is represented by 526.

531. Sample of the above narrow dyke-like belt, which is similar to No. 529, but seems to contain free quartz. The general dip of the rock 528 is to the east, as seen in passing inland, and along the road to town, so as to throw it, if continued, under the rock of the promontory.

532. Reddish, and sometimes greenish, trap-like rock, surrounding, or embracing pieces of the feldspar at Beaver Bay. This rock is similar to rock No. 526, at least in some of its parts. The feldspar masses have the appearance of having been carried in this rock, or to have been *in situ* when it was deposited as a sedimentary rock, and subsequently to have suffered the metamorphosing forces with it. (V. No. 816.)

533. Rock of the great palisades. (V. 139.)

At the point that encloses the beach of gravel at Little Marais, a red pebbly conglomerate is seen running under the basaltic trap (No.

160) that makes the point, but separated from it by about two feet of amygdaloid that bears white thomsonites. This conglomerate must be that seen a short distance below Baptism river (155). The Sawthuth Hills, a spur of which runs out at Baptism Pt., run here still further back from shore, so as to bring the lower beds of any rock involved in them, at the shore along Little Marais. This conglomerate is also probably the real rock underlying the long stony beach extending for a mile or more above the point that is on the west of Little Marais.

East of Little Marais, for a couple of miles, the coast is formed by the Little Marais trap, sloping rather steeply into the water. The underlying amygdaloid is exposed also. The conglomerate is sometimes converted into an amygdaloid, and its true original character is hardly discernable. There are, however, red blotches that indicate the original pebbly character of the whole.

These three parts:—

1. Basltic trap-rock.
2. Reddish amygdaloid.
3. Reddish conglomerate.

make a jagged coast, with sharp points and little bays, almost continuously rocky, to about a mile and a half or two miles east of Manitou river. They sometimes rise 40 feet perpendicularly from the water. There is a little harbor from S. W. winds about one mile east of Manitou river. There seems to have been one grand igneous overflow here, just after the conglomerate, which is about 70 feet thick. The conglomerate itself is amygdaloidal, and the whole is red. The pebbles also are amygdaloidal, and generally less than an inch in diameter, but some are 8 or 9 inches across. The amygdules are calcite, laumontite, and white thomsonite. Sometimes beds of conglomerate and amygdaloid not conglomeratic alternate two or three times, and sometimes they blend or cross each other, showing no widespread variation in the nature of the conditions under which the whole was deposited, but rather indicating that at other points the whole would be found to be a conglomerate.

534. Samples of red amygdaloidal conglomerate from 1 mile east of Manitou river. The same is seen at the mouth of Manitou river. At this point the strike of the trap passes some distance inland, forming a spur of hills that rise several hundred feet back of Pork Bay, with low tillable land along the shore.

535. (V. No. 193).

Thomsonite amygdaloid, from Terrace point, near Good Harbor Bay.

535. A.—Thomsonites, picked from the rock at Terrace Point.

535. B.—Thomsonites, &c., gathered from the beach at Terrace Pt. These pink thomsonites seem to have some of the characters of edingtonites, as in a weak H. Cl. solution they give a precipitate with sulphuric acid, which must be sulphate of baryta.

536. Samples of the basalt rock, at Grand Marais, many of the small pieces being sections of the smaller basaltic columns.

537. Bedded trap, from the west side of the point on S. W. ¼ Sec. 10, T. 61, 2, E. Similar to the trap at Grand Marais. (V. 211.)

538. Red rock, similar to the rock of the Great Palisades. This is the first rock east of Cow's Tongue Pt. in the bay. (V. 212.)

The rock of Fish Hook Point (No. 213) lies as an overflow, and is visible under the water toward the west for some distance, cut also by dykes, some of which appear on the shore.

539. Brown trap, with chlorite amygdules; similar to, if not the same as the Fish Hook Pt. rock, from a short distance west of the mouth of the Brulé river, near the river. (V. 220.) There is no rock at the mouth of the Brulé, but a remarkable high beach, which shuts in a lagoon on the landward side. The pebbles composing it are of mixed character, some are red, from the red rock of the country (538), and some are blue or green, from the fine basalt or dykes, with amygdaloid and porphyry pebbles.

540. Coarse doleritic trap; a mile and a half east of the Brulé river. This rock sets in immediately east of the Brulé (No. 221), and forms the coast nearly continuously. At the point where this sample is got there is a little eastward facing bay, and a gravelly beach, but the same kind of rock is found on the east of the bay. This rock is light gray under the friction of the beach-gravel, but is black with rough lichens when washed only by the water. This rock seems to lie under the red rock which disappeared under the lake on the west of the Brulé. It continues to Horseshoe bay, on the west side of which is a basaltic bluff like that on the west side of Sickle bay. In the interval between these two bays the rock is occasionally interrupted by short re-entrant bends in the coast, where stony beaches largely made of the trap of the country are found, but the most of the distance is rocky and generally less than ten feet in height. The bluff on the west side of Horseshoe bay is 60 or more feet high (V. No. 228).

There is a high range of hills that run across the head of Double bay, rising apparently from the coast in spurs, one from the west side of Sickle bay, and one from the west side of Horseshoe bay. This range is short, as it can be seen for only three or four miles. The top is of the rock No. 540, which probably lies under the red rock and over the Grand Portage slates and quartzyte. It seems to be the same as the basaltic rock that caps the hills of slate and quartzyte along the international boundary. The beach at Cannonball bay is of rounded stones of all sorts, but a little sandy patch is covered with iron sand, derived from No. 540 inland. The rock 540 is seen to run below the E. Palisades, or the "red rock," so-called, judging by the general topography and the prevailing trend of all the beds. As the trend of 540 passes inland, a range of hills rises several hundred feet, extending N. E., the "red rock" occupying the low land between them and the lake, cut by heavy dykes of basaltic green trap. The Eastern Palisades have a short exposure just west of the mouth of Red Rock creek, rising gradually up from the water to about 25 feet, and then breaking off square and suddenly on the land side. They extend perhaps 150 feet along the coast in this manner, but are wider in a low exposure half covered with beach pebbles toward the west, at least 50 feet. The dip here is toward the southeast, but at Red Point, about a mile and a half further east, it dips S. W., at an angle of 25° or 30°, showing the underlying trap again on the east side. Between the Palisade rock and rock 540 seems to be a firmer trap rock, or rock resembling the Two Harbor rock, which appears in the bay east of Red Point, where it is cut by dykes.

The high range of hills that culminate in Mt. Josephine are made up largely of the rock No. 540.

At Grand Portage Island is a section of the rocks just lower than the "red rock," which here seem to have been preserved and thickened, as well as hardened, by local inflows of trap. The island itself is elongated east and west, but not much. It is rudely elliptical in horizontal form. Its highest parts are at the eastern end, where the bluffs, that face north are about 100 feet high. There is a gravel spit that is formed by the joint and opposite action of waves from the east and west as they whip round the sides of the island, jutting northwest from near the middle of the north shore, and from it a shoal extends still further in the same direction. The beach shows foreign drift-boulders, as well as many varieties of rock from the island itself, among the former being various porphyries and granites. The only piece of "Winnepeg limestone" found on the "north shore" was found on the northwest side of this island, though a fossiliferous piece of chert was picked up at Good Harbor Bay. There are also pieces of dark, hornblendic rock, and of micaceous schist that do not occur in the rocks forming the island, as well as a good many fragments of the "red rock." These last are so angular, and also so frail, that they seem not to have been far transported. They are perhaps from below the water of the lake south of the island, and are thrown up and brought ashore by ice and waves. Some of the "red rock" is rather sandy, and spotted with light brown spots, like the shale and sandrock of the St. Louis river, the spots being pink in the dark red. Some of the fragments are confused in structure as if crumpled, and are amygdaloidal; and some are harder and porphyritic, resembling the typical Palisade rock. The main beds of the island dip to the S. S. E. at a varying angle, and have an exposed aggregate thickness of 134 feet, viz:

541. At the N. E. corner of the island a dyke 10 feet wide cuts the quartzyte and conglomerate, running E. 10° N. by needle, without displacement of the bedding. It is a very fine-grained black, or blue-black rock.

542. A layer of trap like No. 540, which on the east shore is basaltic, rising about 12 feet. This is stratigraphically the highest rock in the island.. 14 ft.

543. A chalcedonic amygdaloid, though the chalcedony and calcite amygdules appear specially at the south east end of the island, may be.................. 20 ft.

544. A curious, dark, heavy, globuliferous trap-rock, disintegrating readily, the hard globules, which are of stony structure (not minerals) and nearly black, rolling out like shot, or bullets, and covering the ground after the rest of the rock has rotted to a greenish soil. The rock itself is chloritic and dark green. This is in a belt crossing the island east and west, appearing some like a dyke, but is in reality probably an overflow like the next underlying. Indeed it seems to pass into the next, in some places, showing it is only a local phase of a larger bed. It is the last to run under the water at the west end of the island, and at the east end it is the topmost rock in the bluff. Its thickness may be... .... 20 ft.

545. A bed of fibrous green trap, passing through the center of the island and forming its highest parts, and also producing a long sloping beach on the S. E. side running under the chalcedonic amygdaloid. In the center of the island it appears like

a burnt scoria or slag, due perhaps to the effect of Nos. 543 and 542, though these have been removed in the central part of the island appearing now only along the south and southwest shores . 35 ft.

546. Sandrock, even-grained, rather fine, light colored, but of a pinkish and purplish cast, firm and compact in regular beds of 10 to 18 inches thick..... 8 ft.

547. Another bed of trap, like the dyke No. 541. This is sometimes brecciated, or finely and irregularly jointed, with white nodules of saccharoidal calcite.. 36 ft.

547A.—Nodules of saccharoidal calcite from 547.

548. Quartzyte, sometimes with mica specks between the beds, of a dark color, generally striped with red and brown, some of the beds being brown-red, with thin laminations, and some show ripple-marks.. 5 ft.

549. A breccia, or conglomerate-breccia, the cementing rock being a quartzyte like No. 548, or arenaceous like a grit.. 16 ft.

550. Near the dyke (No. 541) is another which cuts the beds, running E. 10° N. This is a little south of No. 541, and is 34 feet wide sloping a little to the north.

551. Another dyke crosses the S. E. corner of the island in direction N. N. E. by E. and is of a coarse dolerytе. It is probably due to these dykes that the island exists, as by their intersection their effect has been to harden the beds, and to present toward the east the apex of a triangle to ward off the waves of the severest storms.

There must be, besides the foregoing, also the following nearly associated with them—although they do not appear any where in the bluff soft he island—since they are seen in fragments on the beach.

(a). A true pebbly conglomerate, or coarse grit, nearly white or of a light color.

(b). A true conglomerate like (a), but containing pebbles, at least crystals, of red feldspar.

(c). A conglomerate with few pebbles, but a green aluminous, or chloritic cementing material.

The true place of these cannot be ascertained, but (a) is probably near the bottom of No. 546, as well as (b), and (c) resembles the shale and sandrock cut by dykes in the bay east of Red Point, (Nos. 232 and 235), which must be just under the "red rock," and so probably belongs near the top of, if not wholly over, the foregoing section. Indeed it must come, in that case, from the lake, below the water.

A generalized section of the alternating beds of the formation as they occur along here would be as follows in descending order:

1. The Palisade rock, or the "red rock."
2. Green shales, &c., in the bay east of Red Point, (Nos. 232, 235, 238 and 239).
3. Layer of trap like 540 (No. 542)...................... 14 ft.
4. Chalcedonic amygdaloid (No. 543).................... 20 ft.
5. Fibrous, green trap striking E. and W. through the island and forming its highest parts. In spots it is globuliferous with hard, dark, strong, shot-like pellets about ¼ in. in diameter, (Nos. 544 and 545),... 35 ft.
6. Even grained sandrock (546)......................... 8 ft.
7. Trap bed, finely and irregularly jointed, with nodules of white saccharoidal calcite (No. 547).......... 36 ft.
8. Quartzyte (No. 548)................................ 5 ft.
9. Conglomerate (No. 549)............................. 16 ft.
10. The rock No. 540, forming the great trap covering of the quartzyte hills at Grand Portage, 50 ft....... 250 ft.
11. The slate and quartzyte terraces seen in the hills at Grand Portage, generally and along the international boundary as far west as the west end of Gunflint lake(estimated)........................ 400 ft.
12. The jasper and iron ore beds of the Misabi, and southeast of Vermilion lake.
13. The micaceous and chloritic schists and slates of Vermilion lake and the Dalles of the St. Louis river.
14. The mica schists, granites and syenites of the region north of Gunflint lake, (V. after No. 753).

This takes no account of the great labradorite range, which in some places forms the Mesabi, nor of the iron ore deposits of Mayhew Lake, because they are apparently included in the rock Nos. 258 and 540, or in an immense outflow of molten matter at a date somewhat earlier. (V. Nos. 695 and 816.) Nor does it mention the conglomerate of Ogishkie Muncie lake, because that is apparently an incident of the slaty and talcose beds included in Sub. No. 13, nor the red granites of the region of Brulé Mt. because they are probably a modified condition of the Palisade rock.

Nine dykes are seen crossing Hat Point on the west side of Waus-waugoning bay, cutting the slates and quartzytes near the water, running a little northeasterly varying from 3 feet to 70 feet wide. A heavy dyke of basalt runs along the head of the bay terminating the bay in that direction. It cuts the slates, hardening and solidifying them so that their walls, broken and oblique, sometimes stand alone, appearing like other dykes. It runs on into the "Cypress Swamp," of Norwood, and appears to be the same that forms little islands in the south arm of Pigeon Bay.

552. Plumbaginous quartzyte, Pigeon Pt., near the trail to Parkerville. Sec. 32, T. 64, 7. (V. No. 270.)

553. Quartzyte, near the portage trail, at the north shore.

The Grand Portage range of hills laps over another as it approaches Parkerville, and also gradually dies out, the Pigeon river coming through the low spot in the valley between them. The other range runs along the north side of Pigeon Bay, in Canada, turning a little northwest as it approaches Parkerville.

554. The "Two Harbor Rock," (?) from the east end of the island most easterly, separating Washington Harbor from Grace Harbor, on Isle Royale. This is more coarsely jointed than the Rock at Two Harbor, and has somewhat the appearance of an imperfectly basaltic dyke, but as it develops a few rods further north it appears as an overflow, t least it lies on other trap and amygdaloid. It forms a little boat-harbor where fishing shanties are erected. It is at least a fine-grained brown, trappean rock, and in this section seems to hold no free quartz.

The south side of Grace harbor is of pebbles and stones, the pebbles derived from a red conglomerate that occasionally is seen in the beach, but which in the S. W. corner of Isle Royale is finely exposed. This red conglomerate is coarse, some of the stones being over a foot across, and dips for a long distance gently toward the south and southeast. On approaching the point in the coast nearly south of Siskiwit bay, the dip increases, and still more toward the entrance to Siskiwit bay. Above the conglomerate appears a red sand-rock, nearly a red quartzyte, resembling rock No. 548 of Grand Portage Island. This has regular bedding, cut into cuboidal or rhomboidal blocks by divisional ripple-marked with some softer, shaly or hæmatitic laminæ, and with hæmatitic lumps of shale more or less inclosed in the mass of the beds themselves. Some of these beds are about 30 inches in thickness, and some are less than an inch. These beds are firm and durable, blackening under the waves like a trap, to which at a distance they have some resemblance. Its dip, color and bedding recall the red quartzyte in S. W. Minnesota, but it is rather less siliceous than that. In the same manner, however, it overlies a coarse pebbly conglomerate, which in the same way indicates its relations to the red quartzyte of Grand Portage Island and of Pigeon Pt. peninsula (No. 290), as well as to the red sandrock and shales of Fond du Lac.

At Grand Portage Island it appears that a trap inflow separates the red sandstone and shale formation into two parts, only a small portion being below the trap, the greater portion being out in the lake further south, while on Isle Royale no such trap overflow divides it.

555. Red quartzyte or sandrock from Siskiwit Point, Isle Royale (the point that encloses Siskiwit Bay). This has been quarried further west in the bay, on the south shore, and advertised in Detroit under the title "Isle Royale Brown stone," by Buchan & Co., 117 Griswold St. West from the point, on the south shore of the bay this rock stands out prominently, dipping from 10 to 20 degrees to the south, forming a jagged and rocky coast, having a perpendicular rise from the water the most of the distance to the first bay on that side. Altogether there must be three or four hundred feet in thickness of these beds, involved in the point that shuts in the bay, but they actually rise above the lake but about 60 feet. The former beds do not lie immediately on the coarse conglomerate, but are separated from it by a shale, which appears at the point forming the first little bay west from Siskiwit Point. This red shale, though appearing rocky, breaks with a sectile fracture, into a great many small pieces when struck with a hammer. It is bedded like the quartzyte, but is intersected by numerous *gashes*, or gash veins, which are of a very different color, being greenish, or greenish gray, and about one-fourth to one-half inch wide and but a foot or two in length, running nearly north and south as they appear on the weathered surface, though some are irregular in direction and follow other cracks. These gashes seem to have been caused by the change produced in the rock by the gases escaping through fissures produced by the disturbance of the formation, rising from heated regions below, rather than by the downward effect of heat from trap overflows. This shale is the most destructible of the whole formation, and probably is

mainly the cause of the low swampy land that intervenes between the head of Siskiwit Bay and the S. W. corner of Isle Royale. The conglomerate itself is under the shale, and is more durable.

556. Red, hardened shale, south shore of Siskiwit Bay, as above described.

The same red conglomerate that forms the S. W. end of the island also forms the north coast of Siskiwit bay, and is the rock containing the copper at the Island Mine, which is near the head of the bay.

557. Cupriferous conglomerate, from the Island Mine, Isle Royale near the head of Siskiwit bay; this is also argentiferous.

557 A.—Variety of pebbles from the conglomerate, 43 kinds.

557 B.—Stamped rock and copper. Island Mine.

558. Amygdaloidal dark trap, near the stamping mill of the Island Mine, Isle Royale. This is near the creek coming through the location.

558 A.—Wernerite, from 558. This mineral has the following chemical and blowpipe reaction:

Blowpipe Reaction of No. 558 *A.*

Fuses at 2 or 2.5, with intumescence.

After fusion gives a quick alkaline reaction when moistened on turmeric paper.

Gives no sulphur reaction on silver.

Salt of Phosphorous bead shows a skeleton of silica.

H Cl. solution does not gelatinize.

H Cl. solution gives no precipitate with Ba Cl.

H Cl. solution gives slight precipitate with NH_4 HO.

In closed tube, B. B. gives no water or the slightest trace only.

Fused and moistened with H Cl. gives a copper flame.

Some fragments effervesce slightly in H Cl.

H Cl. solution gives no precipitate with S. O.

Hardness 5 or 6.

Color, light, lilac-gray, or a pinkish white, or white.

Structure, massive, or fibrous and divergent, the rays becoming separated, acicular, tetragonal crystals.

H Cl. solution does not give titanium reaction with tin.

Borax bead is slightly yellow from iron.

H Cl. solution does not gelatinize even after boiling.

After fusion the H Cl. solution gives no jelly.

These characters bring the mineral between Wernerite and Cancrinite. The occasional effervesence allies it with Cancrinite, but its color and the tetragonal form of the fine crystals show it to be Wernerite. The effervescence is probably due to something attached to the fragment. This mineral is in amygdaloidal cavities or irregular openings in the trap, some of the masses being two inches or more across.

558 B.—In 558 are veins of a green rock which is heavy and amygdaloidal with what also appears like Wernerite.

559. Trap that immediately overlies the cupriferous bed of conglomerate, at the Island Mine.

560. Trap that forms a bed under the cupriferous conglomerate, known as the *Greenstone Range* where it rises to the surface further north.

561. Decayed rock, or volcanic ash, so-called by Norwood, from the cupriferous bed of the conglomerate.

At the location of the Island Mine, a beach, apparently formed by jamming of ice, is 95 feet above the water. The road from the dock to the mine runs on it some distance. There are other beaches or ridges, lower, some of them running somewhat transversely across the intervening space. These are short, and more evidently due to the jamming of ice. The 95 feet beach is the upper limit of a strictly pebbly surface; above that the surface being one of loam and gravelly clay, or a stony loam, so that there may be said to be a soil. Below the top of this ridge, as well as wholly over it, there is absolutely no soil,—only red gravel and stones derived from the conglomerate, with an occasional out-crop of the conglomerate itself.

The conglomerate slopes southward into the water of the bay all along the shore, but between the shore and the mine several trap and amygdaloid beds appear, having a bearing, or strike, apparently in the direction of the coast, the whole of them being near the mine. The location of the mine is from 250 to 300 feet above the lake, and about a mile north from the bay The shafting is in the conglomerate rock lying between trap beds, and slopes towards the south with the dip of the formation.

There is some coarse sandstone, or grit, disseminated among the conglomerate, some beds being a foot in thickness, but fading out to the right and left.

The mine is not now worked (1879) and has not been for a couple of years. There is not a man, woman or child here, but there are many houses, stores, shops, and offices, including a Court House, this being the county seat of Isle Royale county. Everything is deserted. The machinery is mostly still here. The cars, shovel, and various accoutrements lie simply abandoned. The mills are perfect, the enginery for stamping and washing the ore being still on the ground and in good condition.

Toward the east from the dock of the Island Mine the coast is wholly occupied by the conglomerate, or by the overlying slate and sandrock, as far as Wright's Island, but the beach much of the way is formed of drift-brought stones.

562. Trap, somewhat decayed, from a niche in the coast line, south of the east end of Siskiwit lake. This is under the sandstone, but over the conglomerate. It rises from the water with a dip to the south. It has involved with it irregular beds of a porphyritic, harder rock, and patches of epidotic green rock.

563. The porphyry is finer than the porphyry of the pebbles of the conglomerate, but it seems possible that these porphyritic belts may come from a metamorphism of patches of that conglomerate holding such pebbles. The trap is confusedly bedded. The porphyry is also amygdaloidal, mottled with green and red-brown, with white calcite. At Chippewa harbor beds of sandstone and shale are between beds of trap, visible on both sides of the entrance dipping about 35 or 40 degrees to the south. On the east side but one bed of sedimentary rock is visible. It has a thickness of perhaps 75 feet. The overlying trap rises perpendicular perhaps 45 feet. A little further west a trap rises from below the sandrock and shale, and west of that another lower bed of fine shale appears in the coast line, the last being about 10 feet thick. On the west side, near the entrance, are visible two beds of shale and sandrock, alternating with trap. The trap contains fragments of shale and of angular quartzyte along a thickness of about a foot just over the shale-bed. The trap separating these beds of shale seems to be about 120 feet thick. That on the top of them, which also forms the coast line either side of Chippewa harbor, is also about 100 feet thick, and over that is much more sandstone, forming islands off the coast five or six miles west of the harbor. Chippewa Harbor enters nearly at right angles to the strike of the rock-beds, but after passing the narrows it turns more southerly and passes along the strike behind the bluffs formed by the foreging layers.

564. A white mineral from the trap at Chippewa Harbor, on the east side near the entrance, appears to be the same as the Wernerite from the trap at the Island Mine, but it has somewhat the appearance of pectolite. In this lot are also some green amygdules which are closely associated with the Wernerite in the rock.

565. Calcite, from a mass on the beach, containing a green radiated mineral like prochlorite, also Wernerite, and a little quartz.

566. From an amygdaloidal bed of trap that disintegrates, near the narrows of Chippewa Harbor. These green amygdules appear some like chlorastrolites, but they are probably some form of chlorite.

They have a radiating, fibrous interior, sometimes several centers in one mass.

The trap-rock of Chippewa Harbor, without exposed sandstone, continues to the little bay next south of Conglomerate bay, known as Lucky bay, where the rock is of the same kinds and probably of the same horizon as Nos. 562 and 563.

567. From Lucky bay, showing a passage from porphyritic trap to non-porphyritic. This porphyry is from the trap of the place, but it is in patches, or lenticular beds that are generally less than a foot thick, the mass of the rock being porphyritic; but sometimes having a few amygdules of green chlorite. The face of the rock shows a spotted surface when water-worn and partly decayed like much of the trap of the north shore.

568. Trap-rock, taken from the Saginaw Mine, near Conglomerate bay.

569. Epidotic rock, from the Saginaw Mine, the same being the ore of the vein mined for copper.

570. Amygdaloid containing calcite, chlorastrolite and chlorite, from the rock at the light house at the entrance to Rock Harbor.

570A. Chlorastrolites picked from the beach at Rock Harbor.

570B. Green "thomsonites," chlorastrolites, &c., from Rock Harbor.

Conglomerate bay has no conglomerate at the entrance, but toward the head of the bay it is found. The trap is crumpled and faulted between Lucky and Conglomerate bays, and dip generally E. S. E.

At the Siskiwit mine the work was on a vein of epidote and calcite. In the islands opposite is a bed of conglomerate, embraced between trap beds.

571. Samples of trap and gangue rock, from Siskiwit mine, Rock Harbor.

572. Trap rock from Scoville's Pt., Isle Royale.

573. Radiated, white, fibrous, zeolitic mineral from the trap at Scoville's Point, picked up on the beach.

574. Trap rock from the extremity of Black's Pt., east end of Isle Royale.

575. Thomsonites (?) and other zeolitic minerals, from the beach of the mainland, north shore of Isle Royale, about two miles S. W. from Lock's Point.

576. Prehnite and copper (some attached to the amygdaloid from which they come, from the little bay at the east extremity of Fish Island .

577. Black oxide of copper, from the Minong mine, Isle Royale, attached to a large piece of the rock.

578. "Stamp ore," showing the nature of the rock in which the copper occurs.

579. Shows an occasional form of the rock in nodules, also included in the "Stamp ore."

580. Coarse green amygdaloid, the cavities being filled with chlorite or with geodic quartz with interior rosettes of chlorite, coated with green—the amygdules making up more than half of the bulk of the whole. It also shows some calcite and some laumontite. This adjoins the copper-bearing rock.

581. Native copper, from the Minong mine, Isle Royale.

582. Native alloy, and intimate mixture of copper and silver, Minong mine, Isle Royale.

583. Native copper, with attached crystals of—?

584. Battered copper, found about the large masses worked by the ancients.

585. Stone hammers used by the ancient miners at the Minong mine, Isle Royale. These are generally rounded or oval pebbles of fine basalt, evidently transported from the north shore of the lake, where they got their form by the action of the waves on the beach. They are not withed*. They are found in the debris about the old pits

586. Wood, found in the ancient dumping heaps.

At Silver Islet the shaft in 1879 was 720 feet below the level of the lake. The vein runs about N. and S. in the slates and quartzyte of the region, and varies from almost nothing towards the north to ten or twelve feet in its greatest width, which is where it intersects diorite dykes running N. E. and S. W. (said to be E. and W.) The dyke is set off where the vein crosses it, the east side being further to the south than the west. The richest deposits are near the intersection of the vein and dyke, and are accompanied with plumbago which has seggregated from the organic matter contained in the slates. The gangue-rock is a breccia of slate, filled with calc-spar and quartz, though mainly calc-spar. The silver is native and is disseminated through saccharoidal calcite. It is also found in the galena, but in general the galena is discarded. There are also blende and pyrite. This silver has been lately found combined in new forms with arsenic, antimony, &c., &c., creating new mineral species—Huntilite and

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*See the *Popular Science Monthly* for September, 1881, for an account of these ancient miners, by the writer.

Animikite. The vein seems to have been enlarged in passing the dyke and charged with these minerals. The work is now being pushed north and south, in hope of striking other dykes. In the vein are large spar-lined cavities in which gas accumulates, (carburetted hydrogen) which has caused some trouble from its slightly explosive character. Water gathering in the mine is strongly charged with some gas, probably the same, but at the bottom of the mine in the "diorite" rock, no water accumulates, and it is necessary to carry down water to serve the drill which is driven by compressed air, the same operation ventilating the shaft. The great deposits of native silver have been in near connection with the dyke, and the large cavities with calcite and galenite are in the same way related to it. The plumbago is along the hanging wall, and is closely connected with the "diorite" of the dyke—indeed is permeated sometimes with igneous rock matter.

587. Calcite and galenite masses with crystalline points perfect. The galenite here is in octahedrons instead of cubes.

588. Mass of octahedra of galenite, Silver Islet.

589. Plumbago, Silver Islet.

590. "Diorite," from the bottom of the mine, Silver Islet, 720 feet below the level of Lake Superior.

591. Saccharoidal spar, which is the gangue-rock.

592. Cemented breccia, from the vein.

593. Igneous rock, from the vein.

594. Slate, that incloses the vein.

595. Cores of the diamond drill, Silver Islet,

596. Stamp ore, with saccharoidal, flesh-colored calcite. Silver Islet.

596 A. Huntilite, from the Silver Islet mine, an arsenate of silver, antimony, cobalt, &c. (Wurtz.)

The following general section was taken at Silver Islet Landing. Some of these beds are seen only at a mile or two north from the lake. It is given in descending order.

(1.) Mottled, red-and-bluff, fissile shale, checked and crumbling into small angular pieces; below conglomeritic and lighter colored, siliceous limestone and chert predominating, ashy and loose........ 40 ft.

(2.) Light-red dolomitic sandrock, some parts being red sandrock, weathering generally of a light color 35 ft.

(3.) Siliceous conglomerate, with rounded pebbles...... 5 ft.

(4.) Greenish, weathering dark, fissile sandrock, appearing at a distance like thin-bedded slate—really fine-grained and aluminous, apparently the top of the slate and quartzyte in which the silver occurs. The transition is gradual from a hard quartzyte and slate, near the bottom, to an arenaceous slate, through a greenish color which is first brownish and then reddish, thus getting the color of the beds higher still. Seem.............................. 55 ft.

Seem total..............................135 ft.

There is, presumably, slate to the thickness of about 50 or 60 feet more, hid by tubes. The above are all conformable, so far as can be seen here, and are cut by "diorite" dykes running to the top.

597. Fissile, mottled red-and-buff shale, from No. 1 of the foregoing section.

597 A. Siliceous and cherty, with calcareous nodules, from the lower, and conglomeritic, portion of 597.

598. Light-red dolomitic, sandrock, compact, mixed with red sandrock, from No. 2 above.

599. Siliceous conglomerate, from No. 3 above.

599 A. Pebbles from 599, water-worn.

600. Greenish fissile slate, from No. 4 above. Aluminous and fine-grained. The samples are rather too quartzose to fairly represent the bed. They are from the lower portion. The higher beds are softer.

601. Coarse porphyritic "dioryte," in a dyke running parallel with and contiguous to and passing into

602. A fine-grained dioryte, in the form of a dyke. The interval of transition is perhaps two feet wide and the crystals of feldspar are scatteringly disseminated through it on the south side, and wholly disappear on the north side. They run in the same direction as the dyke on Silver Islet. The whole is 45 feet wide, but is evenly divided between Nos. 601 and 602, from about a mile north of the "Landing" at Silver Islet.

Pigeon River Falls are formed by the range of hills of trap that set in near the head of Wauswaugoning Bay. The range is an immense dyke cutting the slate, and continues east so as to make the peninsula that separates the bay into North and South Arms, but undulates up and down. It is in one of the downward undulations that the falls occur. Probably more of these hills than has been supposed, are simply dykes piled up over the fissure when the rock was molten, sometimes flowing over. Hat Point and Mt. Josephine are thus dykes.

603. Porphyritic dioryte, such as cover the hills of quartzyte and slate at Pigeon Pt. From the extremity of Pigeon Pt. (V. No. 291.)

604. Black, fine-grained, hardened slate, from south of the dyke (No. 605) on the point next east of the little bay where the portage passes over Pigeon Pt., on the south shore of Pigeon Pt. The portage is 87 paces over, from the top of the beach on the south side to the same on the north side, and passes wholly over moss-covered, loosened fragments of rock.

605. Dyke-rock, cutting the slates and quartzyte, 35 feet wide, at the bay where the little portage crosses the point.

606. Rock of the surface next north of the dyke, in contact with it.

607. Modification of the quartzytes next north of the dyke, and under No. 606, fine-grained quartzose syenite, some of it not showing orthoclase.

608. Fine-grained, reddish quartzose syenite, a modification of the quartzytes, under No. 606.

609. Similar to the last, but further from the dyke No. 605.

610. Similar to the last, but more red, further from No. 605.

611. Red, fragile syenite, a further modification of the rock underlying the rock No. 606, and further within the bay.

612. A further modification of the same beds or underlying beds, from a few feet within the bay toward the portage trail, northwesterly from 604. This is evidently mingled with igneous matter, though having a slightly red color. There is a fine cross-jointage in 610 and 612 that resembles that of some igneous dykes, but this is not anywhere seen.

The relations of 607—612 to the dyke and to the quartzyte cannot be stated positively, for the whole situation is confused, yet the position of the beds from which they are derived is such that they would succeed each other in descending order. No. 604 seems to be the quartzyte hardened. It forms a surface sloping to the lake. It is cut by No. 605, but as 605 rises five or six feet above the lake it comes in contact on the north side with 606, which, while so situated as to be the apparent continuation of 604, has a very different lithology. It is much like the rock 603, at the extremity of the point; is coarser-grained than 604, but has free quartz and horn-blende. No. 606 overlies the numbers following to No. 612. These last cannot be said to come exactly in the order numbered, but probably do approximately. The layers are in strata and dip S. or S. E. weathering out thin-bedded.

The samples did not come from successive beds, but rather at increasing distances along the beach, somewhat descending in the strata. The fragile parts (Nos. 611 and 612) are at once followed by the pebbly beach where the portage trail passes over to the north side. These are piled in successive steps upon each other to the height of 15 feet, and continue across the bay. It was doubtless owing to the occurrence of these soft beds, which rot and chip up, under the water and ice of the lake, that the break-down in the peninsula exists here.

613. On the west side of this little bay the point consists of rock like some of the rock on the other point (607—612), but is hard and firm. It has a resemblance to the plumbaginous quartzyte (552), but with the naked eye no plumbago can be detected.

614. Near the point a dyke cuts this rock, blackening and hardening it. The dyke seems to dip N. E. so as to stand at right angles to the dip of the quartzyte, and the north wall is very distinct, the dyke having been torn away by the lake.

615. Rock of the above dyke.

This dyke, which is 12 feet wide, has not the direction of that on the other point, but runs out into the lake S. E. while that on the other point seems to run into the bay, lying to the north of this. These dykes each point toward a hill of quartzyte near the coast a short distance west.

616. Further within the bay, on the west point, the rock bluff facing east is reddish and mottled, like much of that on the other point. Sometimes the prevailing color is red, and sometimes green, but the colors do not apparently change in any observable regularity, or in accordance with the strata. By far the greater portion on the west point is red, while on the east point a green color is more common; bands and veins of red run through the green, or *vice versa*.

The two dykes mentioned at Little Portage bay converge toward a hill near the south coast—indeed the rock forming the point (613) seems to rise and culminate in this hill, though the hill is at last sudden in ascent on nearly all sides. It is about one-half mile west of the portage.

617. From near the base of the hill mentioned, a reddish gray quartzyte.

618. Gray quartzyte, from the top of the same hill. This hill is with the exception of that back of Clark's Bay, the highest on the peninsula, and consists of metamorphosed, highly inclined, basaltified, gray quartzyte. The softer beds that allow of the narrows in the

peninsula form a belt of low land running north of this hill, and striking the north coast N. W. from the hill.

There are four principal elevations on the peninsula. 1st. East of the narrows, forming a basaltic bluff perpendicular from the water on the north side of the point. 2nd. The quartzyte hill near and west of the Little Portage bay. 3rd. Hill at the head of Clark's Bay, north of it. 4th. The hill range cut by the Parker vein. Of these the third is the highest, being about three hundred and fifty feet above the lake.

619. From the same hill as No. 618, on the south side where the structure is basaltic.

This quartzyte assumes forms, structures, colors and positions that give it a very great resemblance to igneous rock. It is often finely or coarsely basaltic (at least cut by numerous N. and S. parallel points), and sometimes rises suddenly to the height of over one hundred and fifty feet. It is dark gray, greenish, red, black. It is globuliferous, or at least disintegrates in a rough or cavernous manner somewhat like trap rock. It is porphyritic, with feldspar. These characters do not combine, but occur separately, and it can hence generally be identified.

620. Rock of the E. Palisades (V. No. 230). This rock is red on weathering under friction, but, being coarsely fissile, or shaly, cut by innumerable seams, it rarely fractures freshly but parts into small augular pieces by a blow from the hammer, showing only greenish coatings in the seams. Its true fracture is ragged. This rock has fine translucent grains of quartz resembling those of the Great Palisades and a general outward resemblance to the rock of the Great Palisades.

621. Thomsonites (?) &c., from a short beach at Lover's Bay. The trap that encloses this bay is dark, but slightly greenish, and amygdaloidal with Thomsonites and Wernerite. They are few and dull in color. They are generally of a pink color, or massive and white. (See after No. 192.)

622. Stilbite, thomsonite, calcite &c., mouth of False Poplar river.

623. Dark, greenish trap, forming the upper layer of the point that encloses Eclipse beach on the east. This is two and one-half feet thick, not amygdaloidal, but very chloritic from decay.

624. Laumontitic amygdaloid, lying below No. 623. This has some stilbite and some thomsonite. This bed by easy disintegration forms two small harbors, one protecting from the N. E. and one from the S. W. The beach of the west harbor is of gravel, and has many thomsonites, but the east harbor is entirely rock-bound. This bed is

about eight feet, but varies some, as the characters of No. 623 fluctuate up and down. The general color is a dull red.

625. Greenish trap, having much thomsonite, prochlorite and some stilbite. From this bed the thomsonites of Eclipse beach weather out. Some of the masses of thomsonites are three or four, or even ten inches across; but in the case of large masses the mineral lies rather in sheets, with radiating points on the upper and lower contact surfaces. Some large masses two inches across also have two or three points of radiation. When polished on the beach the pieces which result from the destruction of the large masses are prismatic, but there are also many round and oval which have not been broken on separation from the rock. These show the circular radiating results of different colors on the outer surfaces when polished on the beach. The colors are pink, red, white and green,—at least the same green mineral is found here, always smaller than the other thomsonites, as is found at Terrace Point. This green mineral often surrounds the pink and white radiating masses of thomsonite. It is itself not evidently radiated, and the radiations of the thomsonite penetrate it.

This rock is very nearly, if not exactly, on the same horizon as the trap at Terrace Point, judging from the run of the beds, as they extend along the coast from that place. The same horizon extends to Poplar river without much deviation. Some thomsonites are to be seen on the beach at Poplar river. The thickness of No. 625 cannot be made out, as it forms the coast-line eastward. (V. No. 187.)

625A. Thomsonites, picked from the rock at Eclipse Beach.

625B. Thomsonites, picked from the beach at Eclipse Beach.*

626. Red laumontitic amygdaloid, from about mid-way between Poplar and Temperance rivers (Nos. 177 and 178). This is in regular beds, of a few inches, or less than an inch, lying like a sedimentary rock. The general color is pinkish-red. These specimens may represent the red amygdaloid of several miles along here, even from Poplar river, though the sedimentation is not so plain in all cases. Over them here is a heavy bed of trap, massive or coarsely jointed. This trap bed forms arched purgatories, and tables extending over the lake, where it extends down to the water, the amygdaloid being eaten out by the lake. Occasional thomsonites occur here on the beach.

From two or three miles east of Temperance river to about half way to Poplar, is a very picturesque and interesting, but difficult coast.

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*This is called Eclipse Beach, because in 1878, in the latter part of July, our boat was driven in here by high wind, and during our enforced stay in the afternoon, the sun was eclipsed about half an hour. Being compelled to spend the night here, our camp was pitched on the bluff and between the two harbors.

The trap and amygdaloid form a thousand fantastic shapes, as the line of the lake level cuts across the undulations of their bedding and change of dip. Sometimes the bridge of trap rock, produced by the eating away of the soft underlying amygdaloid, runs intact down to the lake, forming deep reverberating purgatories in which by the confinement and compression of pockets and chambers of air, the waves that close up the entrance are thrust back quickly again. Sometimes the bridge breaks down, leaving islands of rock just off the line of coast. Sometimes bridge, islands and all are taken away, letting the lake break on the base of the high bluff rising often perpendicular from the water, or skirted by a narrow pebbly beach, a few rods inside the line where the islands had existed. The effect of wave-and-frost-action on a line of stratigraphy of alternating hardness could not be more perfectly illustrated.

627. Dark trap, forming an arched rock at the shore three-fourths of a mile west of Cross river. The eroded bed is one of two feet thickness of stilbite-thalite-laumontite amygdaloid, which lies on a firm bed of trap having thomsonite and stilbite with less thalite.

628. Basalt; mouth of the Manitou river. At this place about thirty feet of trap that shows red surfaces in falling to pieces, lies on an amygdaloid conglomerate, the two together forming precipitous bluffs on either side of the river, with lower stretches where the trap, which is basaltic or semi-basaltic, runs unbroken down to the water. This kind of coast runs east at least to the point west of Pork bay and west to Little Marais. (V. No. 160.)

629. Conglomerate, from the mouth of Manitou river. The conglomerate is crumbling, soft, red, amygdaloidal, the form and original structure of the pebbles being obscured or lost in the metamorphism.

Over this conglomerate at Manitou river the trap (628) is basaltic. Along the coast it greatly resembles the Grand Marais trap. The basalt is bedded, or at least jointed in the direction of the dip, so that the columns break off in pieces a few feet long, leaving a smooth surface below, but one on which the outlines of the tops of another tier of columns can be seen, and which is itself broken away at a lower level, so as to disclose another tier still lower. Thus in successive benches, or tiers of columns the bluffs ascend somewhat irregularly from twenty to eighty feet. Sometimes one of the lower tiers is not broken, but like a dome rises gradually from the water and runs under one of the upper tiers. This regularity is not the invariable form of the breaking away. Instead, a very rough surface, caused by the separate and individual fracture of the columns all over, sometimes runs down to the lake level. This is the case in approaching Little Marais from the east, where at the point the whole range of trap strikes southwardly into the lake and disappears under the water, forming a ragged, rocky point, and letting the coast line on to the conglomerate, which is but little seen, the only exposure being just at the point on the west of the strike of the trap.

630. Green, chloritic trap, from two miles west of Little Marais Point, forms perpendicular bluffs.

631. Green chloritic amygdaloid, from the same place.

631A. Red, compact, rock-like veins in 631. This red rock, which seems to be foreign to the rock 631 in which it appears, is found embraced in veins with stilbite and calcite.

West from Little Marais beach, the first little point is formed by a trap exposure which probably lies below the conglomerate. This continues west under a stony beach for a mile or so, when, with a high dip, it begins to show more and more, and finally to make a continuous bluff twenty to forty feet high. This trap (630) has a very different aspect from the Little Marais trap, being green instead of red, the amygdaloidal portions also being green. It contains stilbite, calcite, chlorite, (thalite) and some thomsonite. This trap and amygdaloid are bedded, but not basaltic. Running through it are seams, one and two inches wide, (631A.) which are made up of layers of stilbite and a red rocky substance that resembles the rock Nos. 7 and 42. On the beach are amygdules of quartz and thomsonite. This rock, taken all together, much resembles the rock at Eclipse Beach, and perhaps, if the horizons could be compared, it would prove to be synchronous in origin.

A little further west, as Nos. 630 and 631 rise above the beach, a reddish amygdaloid is brought into view, which on close examination proves to be a conglomerate. This rises, as the anticlinal bend of the trap passes inland so as to show about thirty-five feet with purgatories in a perpendicular bluff. Under it soon appears another trap which also rises in anticlinal, is broken away by the action of the lake, and discloses in an eastward facing bluff a lower conglomerate bed of unknown thickness. This anticlinal covers about a mile and a half. The beds return to the lake again at the headland about one-half mile still further west. This is on Secs. 29, 30 and 31, T. 57, R. 6, about three miles west of Little Marais.

632. Trap, from a point of rock on Sec. 29, T. 57, 6, separated from the green trap 630 by a conglomerate thirty-five feet thick. This is red in many spots, on account of the red partings along all the

joints, styled heulanditic by Norwood. It is crossed by red siliceous seams about one-half inch thick, and has large lumps of quartz and geodes. These red veins resemble the red vein material of 631A. but not so abundantly accompanied by stilbite. Thickness 12 feet.

632A. Siliceous, jaspery seams from trap No. 632, from a point about one-half mile west of where 630 appears.

632B. In the same beds of 632, or which at least contain 632A. are siliceous geodes, lined sometimes with amethyst, and a great many agates. These are in a bed but little above a conglomerate, and seem to have been derived from the fusion and dissemination of the material of the conglomerate, the same cause doubtless as filled the siliceous veins of 632A. In some geodes the central mass is laumontite.

633. Thin, irregular beds of trap, immediately under 632, containing red amygdules.

634. Nearly the same as 633, but underlies it; this seems to be a heulandite amygdaloid. It is near the top of the conglomerate. It also contains agate, stilbite, laumontite and chlorite. The red coatings and the heulanditic characters prevail along the red seams that cross and re-cross the rock. In some cases the red mineral penetrates the whole and is disseminated generally through the mass in the manner of amygdules.

634A. Amygdules of "heulandite," and of agate, stilbite and chlorite, picked from No. 634.

634B. Stilbite crystals from 634.

635. Greenish, rather soft, fine, sub-crystalline, compact crumbling rock, containing siliceous nodules. At first this polishes under the friction of the waves, but after long exposure it crumbles from the abundance of chlorite. It lies under No. 634 and also has heulandite in the upper portion. Nos. 633-35 have a thickness of only three or four feet, and are variously affected by proximity to the conglomerate.

635A. Stilbite amygdaloid, containing also agatized nodules, jasper, &c., lying below 634. The heulandite material coats the amygdules and all seams and joints; contains some chloritic amygdules.

Beginning with the Little Marais trap bed the succession downward appears as follows in going west along the coast:

1.	Little Marais trap, Nos. 160 and 628	30 ft.
2.	Amygdaloidal conglomerate (No. 629)	50 ft.
3.	Green trap, (two miles west of Little Marais, Nos. 630 and 636,	50 ft.
4.	Crumbling conglomerate, amygdaloidal, seen	35 ft.
5.	Trap, with heulandite (No. 632)	12 ft.

6. Trap, amygdaloidal with heulandite (?) (Nos. 633-4-5,.. 5 ft.

7. Amygdaloidal conglomerate. Thickness unknown.

636. Samples of red granite; resembles the red granite at the west point of Beaver Bay, but is coarser than that. At a distance this is apt to be mistaken for the Palisade rock. Sec. 1, T. 56, 7. This makes a high point, with a perpendicular face toward the S., but there is only a small area of it in the formation. (V. No. 157). This rock passes by slow changes into the Palisade rock. It appears at a number of other places along this part of the shore. (V. No. 643.)

637. Feldspar rock, Beaver Bay, at the west point of the bay, (V. No. 120).

637A. A light flesh-colored mineral, with a radiated structure, in scales filling seams in No. 637. The scales are generally about one-fourth inch thick, but are sometimes one-half inch.

638. Rock at the base of Encampment Island, from the north side of the island, (same as 106).

639. Green, heavy doleritic trap, coarse-grained, from the high bluff about a mile east of Silver Creek. (V. Nos. 105, 819.)

640. Two Harbor Rock, separated from No. 639 by a red amygdaloid, eighteen to twenty feet, as at Two Harbors; at the water level, under the hill formed by 639, about a mile E. of Silver Creek.

641. Trap amygdaloid, Knife river, grayish green, containing thalite and chlorite. (V. No. 91.)

From Grand Marais to Ogishkee Muncie Lake, and Mouth of Poplar River.

The hills that lie near the mouth of Silver creek, and that extend in a chain N. E. from here, are the first of that form and outward aspect similar to the Mt. Josephine class, that can be seen from the tug-boat in going down the shore from Duluth.

The range next east of Carlton's Peak has the same outward form but Carlton's Peak itself is different. Between Carlton's Peak and Poplar river are four prominent hills, rising about as high as Carlton's Peak. West of Carlton's Peak for a long distance, is an unbroken line of continuous high land, but further west still is a very ragged range of hills.

East from Poplar river are two gentle swells of high land at once; then the high land is more even-topped, gradually descending to the coast at Cascade river. The range appears double at Poplar river, a high hill farther inland overlapping the gap at both ends. The same is true at Cascade river.

In passing toward Grand Marais some of the hills, which do not from the S. W. show any semblance to the saw-teeth structure, change their profile, and fall into line as parts of the regular range. The range thus runs to Grand Marais, where it seems to fall away, or to recede from the coast.

The appearance of the hills suggests that the Silver creek range, already mentioned, having the outward appearance of those at Grand Portage, is of the same geological structure, and that the range east of Carlton's Peak, extending to Grand Marais, may be of another geological age or formation.

On the road from Grand Marais to Rove lake there is first a gradual ascent, with some flat spots, to "the summit," which is reached at about 1¾ miles from Grand Marais, where the aneroid shows 785 feet above Lake Superior. There is then an undulating ascent, or flat surface, to near the valley of the stream crossing Sec. 9, T. 61, R. 1 E. when there is a descent of about 40 feet over drift, to the creek, which is by aneroid 838 feet above Lake Superior. The valley here is broad and shallow, without any rock-cut*. The country thence is undulating, with good soil and sub-soil, and rather light timber, to the E. and W. town line, where there is a short swamp, but on the other side of the town line good farming land again returns. The whole distance from Grand Marais, along this road, is a tract generally tillable, even the hillside up which the tract runs. The underlying rock, in the hill seems to be the Palisade rock, probably with igneous rocks in dykes and overflow, but north of the hill the red rock returns again, as may be presumed from the occurrence of loose pieces of the red rock, and its shingle, occasionally on the trail. The rock in actual outcrop is not to be seen on the trail between Grand Marais and the E. and W. town line mentioned.

From the town line north to the Devil's Track river is about a mile. This stream is a little larger than the other, but has a similar valley. There is no rock exposed at the crossing of Mayhew's road to Rove Lake. The valley is in the drift, but most of the stones are from the red formation—either real Palisade rock, or red granite like that seen east of Beaver Bay and at Beaver Bay (V. No. 665).

Along the same road toward Rove Lake, north from the crossing of the Devil's Track river, the red rock continues to form the basis of the country, as shown by the fragments of such rock along the trail, and where trees have been thrown down by wind, to about 1½ miles north of the town line where a belt of coarse dark trap appears, extending perhaps 20 rods, when the red returns for one-fourth mile. Then another belt of coarse trap-rock like that in the Grand Portage region follows for about 20 rods. The general surface is not rough, but undulating. It is covered loosely by a loam, or mold, which supports trees to a certain size. They are generally blown over and afterward consumed by fire which also burns up the soil. There is not much drift.

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*The surveyor's plats here erroneously extend the steep bluffs of rock along both sides of the river.

At the center of T. 62, 1 E. a little knoll of dry land occurs in the midst of a swamp. Here the rock is coarsely crystalline doleryte. At a short distance further an amygdaloid appears, and the "Two Harbor Rock," so-called in these descriptions. This last appears soon after passing a little creek; but the country is in general a swamp, with caribou trail in soft wet moss running among the spruces and tamaracks. The surface is closely underlain by the rock *in situ* or by fragments which are lightly covered by the moss or by a vegetable mold. Among fragments of the "Two Harbor Rock" (and occasionally the rock in place) are to be seen also masses of igneous, coarse-grained rock like that overlying the Two Harbor rock.

642. From about one mile north of the center of T. 62 N. 1 E. on Mayhew's trail. This red rock here which appears as a fine red syenite forms an escarpment about 15 feet high, mostly hid by the trees and moss, facing N. N. E. This is not wholly red within, though it weathers red, but is a reddish-brown, and has red crystalline specks scattered through it. It is in heavy, hard layers, and does not shatter into angular small pieces like the red rock. It contains free quartz. Toward the south the land is higher than this bluff, but the bluff overlooks immediately a swamp, and a creek, toward the north. Toward the west this escarpment rises into a hill 75 or 80 feet high. At the foot of the bluff is the rare feature of a foreign syenite boulder.

643. In the northern tier of sections in T. 62 N. 1 E., where the trail crosses them, is a hill range 100 to 150 feet high, with white pine, birch and white cedar, of larger dimensions than in the lower land. This range is composed of a red rock very much like the last number, approaching the character of the red granite seen east of Beaver Bay (No. 636). Many boulders of such rock are in the road before reaching the hills, and more in ascending them. There are a few also of the gray slate and quartzyte, and some of the Grand Portage igneous rock; nine-tenths of them, however, are of this "red granite."

644. The top of this hill, however, consists of igneous rock. This is not certainly in overflow. It may be as a dyke protruding through

No. 643. East of the Mayhew trail, following the town line between towns 62 and 63, the land rises in a ridge perhaps 200 feet above the country further south. The ridge runs about E. and W. covered with heavy forest, and formed of "red granite." This sample contains quartz and orthoclase, and is not a true igneous rock.

This range of hills, composed of this red rock, appears like a range of upheaval, and finally the country becomes wholly hilly.

645. "Red granite," like 642, from this hill-range, S. W. ¼ Sec. 35, T. 63, 1 E. on a little creek. This rock seems to be the result of higher metamorphism of the coast-line red rock, or the Palisade rock. The change seems to have been gradual. While but little of this rock is encountered along the lake shore, it here constitutes the rock of the country, and rises into considerable hills. This difference of crystallization must be due to greater nearness to the seat of upheaval and heat, which would not be in consonance with the opinion expressed by Messrs. Bell and Logan, locating the belt of greatest disturbance in the bed of Lake Superior. It seems rather to be back in the vein of the lake-basin. Most of the rock is like this number, but there is also much like No. 644, in large masses that fall from the hills, and that lie on the tops of the hills. It is difficult to separate 644 from 645. It seems to be due to a mixed condition of matter from the sedimentary and from the igneous rocks, or perhaps to a complete fusion, and flowing in igneous form, of the same rock.

These hills are from 1,000 to 1,200 feet above Lake Superior, and from 100 to 150 feet above the surrounding country.

646. "Red granite," S. E. cor. T. 63, 1 E.

647. Red rock, like 643 and 645, making hills in N. W. cor. T. 62, 2 E. and N. E. cor. T. 62, 1 E. Associated with this red rock in some way not ascertainable on account of the prevalance of surface mold and bushes, is found the next.

648. This is a darker rock, containing quartz, orthoclase, plagioclase, hornblende, magnetite, viridite, apatite, having somewhat the aspect of the Grand Portage trap hills, but not its mineral composition. It may be only a local irregularity in the lithology, as suggested under No. 645, or due to a profound metamorphism of other sedimentary beds having a different composition originally. There is abundant opportunity for this latter hypothesis, because under the red-rock which is supposed to make by further crystallization the red granite, is an immense thickness of black slates and quartzytes, as seen in the peninsula of Pigeon Point, the strike of which must pass westwardly through the country north of Grand Marais. If the upheaval and metamor-

phism of the red rock, which took place after its deposition, also disturbed with the same long-continued effect the underlying quartzytes, they would be deeply metamorphosed also, and would produce a rock different from a truly igneous rock, and from the overlying red granite. This is also further probable from the observed conformity between the red rock, or red quartzytes at least of Pigeon Point, and the underlying black slates and quartzytes. But at present Nos. 644 and 648, and other rocks like them from the same region, may be con-considered undetermined, though with a probability of an original sedimentary condition.

649. Sample of the rock seen in loose pieces along the trail going N. between Sec. 36, T. 63. 1 E. and Sec. 31, T. 63, 2 E. A high hill runs along the east of the trail, the trail being west of the town line. This is a red syenite, but with much magnitite and hornblende.

650. Another sample of dark dioritic rock. This is so abundant that it must be in place near, but cannot be seen.

651. Magnetited dioryte, from boulders, seen along the same trail, twenty to thirty rods north of the last. This same rock forms a hill along the right of the trail. This resembles the Herman iron ore (No. 514), but it seems also associated with the dark rock No. 644 and 648, which is regarded as originally a sedimentary rock.

Across the creek which passes north near the town line where this iron occurs, is another hill made of the same rock showing a perpendicular wall facing E. rising about fifty feet, viz.:

652. Dark, heavy dioryte (?) with magnetite, from a point about one-fourth mile from the Brule river, and half a mile west of the town line.

653. Red rock, from the Brule, some west of the town line. This rock still prevails, thrown up by trees.

But immediately across the Brule, on the town line, between it and the head of Elephant lake, is a low range of trap hills, of the kind characteristic of the Grand Portage district. This rock here rises in domes, and the rock it lies on cannot be seen. Yet on the south side of the Brule it apparently lies on the red rock, rising in the hills and ranges higher than this. It is coarse, and not so much magnetited as the rock No. 652, south of the Brule.

North and west of the Brule, the country appears, viewed from a burnt knob of this trap, quite hilly, and apparently the beginning of the broken surface seen along the boundary.

Also west, in the next town, northwest from here, are seen some high hills.

About one-half mile north of the north side of Elephant lake on the town line, large pieces of the slate and quartzyte formation begin to appear, with boulders of the trap last mentioned. The country is more nearly level, but covered with tamarack or spruce in the swamps, and white pine, tamarack, white cedar, poplar, white birch, and mountain ash, on the ridges or higher flats.

A little further on, however, are many pieces of the red rock on the banks of a little creek running west, and as they probably would not have been transported north, but the quartzyte and slate may have been transported south, it is probable that the red rock really extends as far north as this place.

Secs. 18 and 19, T. 63, 2 E, the red rock comes in full force, forming a range of hills running E. and W. across the town line, without a capping of trap. This hill-range is covered with Pinus banksiana, and the ground is carpeted with moss, as in a tamarack swamp. Indeed this carpet of moss is general here. It seems to depend on the rains that are perhaps more frequent about the summits of the hills. The moist winds from the lake encounter the colder land winds coming more from the north, and transient showers are the result.

654. This sample is from a ridge rising about one hundred and seventy-five feet, crossed by the section line running east, S. E. ¼ Sec. 18, T. 63, 2 E. This is plainly an igneous rock of the usual kind seen on the shore of Lake Superior. It is fine-grained and dark.

655. N. E. ¼ Sec. 20, 63, 2. A low ridge of coarse-grained vesicular reddish rock, containing free quartz, probably a condition of the "red rock."

656. At another point, a little further east, this reddish rock vesiccular, and more evidently a condition of metamorphism, not being wholly crystalline.

657. Sec. 16, T. 63, 2 E, (on the southern line, just after the crossing of a creek) is a fine-grained, brown rock, having feldspar crystals handsomely disseminated sparingly through it, and resembling the stellar porphyries, pebbles of which are seen occasionally on the lake shore. It is a dark, brownish rock, which weathers red, but is hard, fine and compact, and shatters under the hammer in memerous preexisting joints which are iron-shot, making sharply angular fragments. This contains fine grains of free quartz, as shown in thin section, and probably comes from the sedimentary beds, associated with the rocks 648, 651 and 652.

658. Further on this ridge takes on the characters of 655 and 656.

659. This rock appears to be in place, but can be seen only in the form

of numerous loose pieces. It has the appearance of constituting the top portion of the ridge (658.) It is dark, coarsely crystalline, and allied to the diorytes (Nos. 651 and 652.) This ridge runs E. and W. nearly on the north side of the trail, and rises about two hundred feet.

On the line between Secs. 15 and 22, in town 63, 2 E. the country rock is the "red granite," but there are occasional patches of igneous rock, and also some traces of drift, shown by pieces of the quartzyte and slate, and by occasional boulders of syenite. The surface is generally moss-covered and wet. At the crossing of the Greenwood river, the boulders are nearly all of the "red granite." Following the line further east, to the little lake on Sec. 13, at the crossing of the stream, the rock is of the dioritic kind, coarsely crystalline, but there are a good many boulders of "red granite" and of slate.

At the crossing of the town line, which is on high land, is considerable good pine, perhaps 200,000 per forty on either side of the trail. The rock underlying is—

660. A gray dioryte, porphyritic, belonging to the same class of rocks as 651 and 652. The "red rock" seems to have continued along the line of the trail, as far east as to one-half mile west of the town line. East of that the country seems to have been in the next underlying beds as far as to—

661. One mile east of the town line (S. E. cor. Sec. 18, T. 63, 3 E.) is a reddish crystalline rock in place, and this continues east two miles from the town line.

662. The country seems to have considerable drift, often of clay, and does not show the underlying rock. The surface is nearly flat. This fine-grained porphyry is allied to No. 657 and is from S. W. ¼ Sec. 14.

663. S. W. ¼ Sec. 19, T. 63, 4 E, on McFarland's trail. Here is a short E. and W. ridge, rising about fifteen feet, in which the rock is the stellar porphyry seen in pebbles on the lake shore. It is fine-grained and brown, but is beautifully set with intersecting tabular crystals of flesh-colored feldspar. The mass of the rock is made up of minute tabular crystals of a feldspar and opacite, with a few grains of chlorite, and very rarely a minute grain of quartz.

In about N. E. ¼ Sec. 30, T. 63, 4 E. is another low ridge, but made of a different rock, being of a coarse porphyritic dioryte, like some already numbered.

The height of land back of Horseshoe bay, three and a half miles from Lake Superior is 960 feet above the lake.

664. At a little more than two miles from Horseshoe bay, appears

a diorite rock, in a ridge, made up almost entirely of feldspar and hornblende. A beach line is distinctly marked back of Horseshoe bay fifty feet above Lake Superior.

Passing up the hill back of Grand Marais, on what is known as the "Iron Trail," the hill is found by aneroid to be 1,063 feet where the trail passes over it, or 278 feet higher than where the Rove lake trail passes the summit. This is about one and one-half miles from the lake shore. The surface descends eighty-seven feet in passing northward to the level of the water in the south branch of the Devil's Track river.

The rock is mostly hid on this hill by drift, some of it being clay on the top, but in the southward slope, where the face is most precipitious, the rock is exposed.

665. Rock from the Grand Marais hill, eight hundred feet above Lake Superior, having a face seventy-five feet high toward the south. Rather fine-grained trap, reddish brown, evidently an igneous rock. The top of this hill seems to consist of this rock, but toward the base, on the south side, the red rock that forms the beach at Grand Marais is so abundant in old tree-roots, thrown up by the wind, that it is unquestionably in place there, though so covered by its own debris that it cannot be seen *in situ*.

The level of the general surface does not fall away again, after reaching the top of the hill, more than thirty or forty feet, when it becomes a swamp of spruce and tamarack, with the usual covering of coarse Caribon mosses. Passing over the swamp, (about three-fourths of a mile) a slight ascent begins, rising again to about the level of the first hill. After a short distance of dry land the surface descends rather abruptly to the south beach of the Devil's Track river, which is eighty-seven feet lower than the top of Mayhew's hill. No more rock is seen to this place, and here can be seen only boulders. The lake from which the south beach flows is thirty-nine feet higher than the river where the trail crosses it.

666. "Red rock," with small glassy crystals like quartz, from the N. E. side of the lake from which the south beach of the Devil's Track flows. Many loose pieces are seen, but none is to be seen in place, the country being drift-covered. Devil's Track lake is forty-nine feet above South Branch lake, or 1,064 feet above Lake Superior. No rock *in situ* appears between the perpendicular escarpment of the Grand Marais hill and Devil's Track lake, so far as can be seen along the "Iron Trail," which strikes the lake on the south shore one-fourth

mile east of the fourth meridian. The beach here shows no rock, *in situ*, but is composed entirely of small augular pieces of—

667, which is evidently the rock of the country, on account of its abundance, and the fresh angles of the outside. It is reddish-brown, compact, rather fine-grained, but porphyritic with flesh-red feldspar of the color of the moss. In the interior are seen, on fracture, green specks probably due to changed hornblende. On the surface these weather out, making a pitted exterior. It also contains free quartz, making it the equivalent of the red syenite associated with No. 1 at Duluth.

The divide N. of Devil's Track lake is 1167 feet above Lake Superior. The swamp, which is one and one-fourth miles on the portage from Devil's Track lake to Tamarack lake is 1152 feet above Lake Superior. About one-half mile N. of Devil's Track lake the trail crosses the fourth meridian, and continues in a general N. N. W. direction to Tamarack lake. The country about is not hilly, but rises perhaps thirty or fifty feet above these lakes. Tamarack lake is 1132 feet over Lake Superior. The Devil's Track rivers enters it from the N. E. and a short distance above the lake the country becomes a vast swamp of tamarack and spruce. In the swamp are occasional dry knolls of gravelly clay and waterworn drift, but in general throughout the swamp the surface is covered with a thick coating of different caribon mosses. The knolls sometimes spread out indefinitely, rising four or five feet above the swamp, making a small flat area of the same characters as the knolls. There is no rock in place. The country is covered with drift. These knolls are of drift.

The agricultural character and value of this swamp are likely to be mistaken. It seems that in all parts of this district, wherever the surface is nearly flat, and the nature of the underlying rock is not such as to allow easy and rapid escape of the surface waters, a swamp of tamarack and spruce (or perhaps in a stony area, of white cedar) inevitably supervenes; the easily drained hilly tracts, which perhaps are so stony and rocky as not to be arable, are *apparently* better for farming, and are now covered with fine timber. A settler would naturally select these uplands, whereas really the low lands are furnished with the better soil, and are freer from stones. This covering of the uplands with a more or less hardy and stunted evergreen forest, somewhat sparse, is characteristic of high northern latitudes, and here seems to be due to the severe, but moist climate which prevails.

Owl lake is about twelve feet higher than Devil's Track lake, or 1,148 above Lake Superior.

668. About one-third way across the portage from Owl lake to Little Pine lake, are low rocky mounds and ridges, twenty-five to sixty feet high, covered with pine. These ridges consist of this rock, a red syenite, with green specks and red feldspathic crystalline surfaces like several other samples obtained in this region.

The kind of country described north of Tamarack Lake, does not continue through to Little Pine Lake, but in a short distance lindens appear in the forest, then white pine, hazel, mountain ash, &c., while tamarack and spruce gradually disappear, the balance continuing to be interspersed even among the pines and in the uplands. Pretty soon the forest is nine-tenths white pine, the rest being composed of white birch, Norway pine, balsam, Mountain ash and Mountain maple, at the same time that the level of the country is elevated to 100 and 150 feet above the adjoining lakes, and is rolling and hilly, with frequent large boulders and occasional exposures of the underlying rock (668). The soil is coarse and stony, with boulders of light syenite and many of red syenite from the rock of the country. It is a rusty, loamy clay, that seems to be the direct result of the disintegration of the stones of the drift, changed by the action of vegetation.

669. Is from what appears to be a dyke, about half way between Owl Lake and Little Pine Lake, though the exposure is not sufficient to show whether a dyke or not. There is a perpendicular wall exposed, running N. and S. near the trail, on the east side, extending about 25 feet and rising five feet, sinking down to the general level on either side, facing west. There is in it a jointage that weathers out in perpendicular bands or basaltic layers, that run E. and W. from one inch to three or four inches in thickness, very much like dykes seen on the shore of Lake Superior. There is also a blind ridge or elevation running east, through the woods, of about the same height, but showing no rock as far as traced. Toward the west, after a low gap of about 40 feet, the surface rises gradually to about eight feet, and in the top is the same rock; but it abruptly sinks away into a valley, while toward the N. W. is a considerable elevation or ridge covered with pine and containing the red granite No. 668. No. 669 seems to be a dyke cutting the red rock, and perhaps breaking through it in a number of other places. It is, indeed, one of the causes of the "red granite" which all of the time is supposed to be due to complete fusion and change of the "Palisade rock," and that to a feebler application of the same force to the red shales and sands of the Potsdam seen in the St. Louis river at Fond du Lac. No. 669 is apparently what Prof. Pumpelly has described as a *melaphyr*—a dark homogeneous trap,

globuliferous-weathering, and sometimes showing in the sunlight large reflecting crystalline surfaces in the mass of the rock, due to crystals of pyroxene that embrace all the other minerals.

A short distance north of the divide between Owl and Little Pine Lakes, on the north slope, the red rock, which is laid bare by the overthrow of a large pine by a late cyclone, shows a smooth glaciation, but no prevailing direction can be distinguished.

Little Pine Lake, which is 1,154 feet above Lake Superior by rough aneroid observations, has no rock visible about its shores, but under the water near the shore can be seen everywhere sub-angular pieces of the red syenite like No. 668. In making the portage from Little Pine Lake to Clubfoot Lake, which is 1,173 feet above Lake Superior, there is a small exposure of the red granite seen on the trail, but elsewhere the rock is either hid, or is of boulders. About the S. and W. end of Little Pine Lake are numerous foreign boulders. The same is true of the S. and E. shores of Clubfoot Lake.

Round Lake is 1,208 feet above Lake Superior, and Abita Lake is 1,349 feet.

670. From one-fouth mile S. of Lake Abita, in the large hill over which the trail passes, apparently a dioryte, consisting largely of hornblende.

671. "Red granite," from the hill near the south shore of Lake Abita, but not certainly in place. The hill rises about 225 feet above Lake Abita and 1,574 feet above Lake Superior, and is separated from the hill from which No. 670 comes by a dry valley, but which has a creek in wet seasons.

672. The same hill which furnishes No. 671 near the lake is made up of this rock toward the top, being a coarse dioryte. In what manner this is related to No. 671 does not readily appear. There can be seen large blocks of this, and some small mural faces, along the north side of the hill, but in general everything is hid by turf, forest and mosses. There is but little doubt, however, but these blocks are not far removed from their natural places.

The lakes of Brulé river, north from Brulé Mt., are 955 feet above Lake Superior, by aneroid, and Brulé Mt. in its highest part is 1,461 feet above Lake Superior. Brulé Mt. does not appear like a mountain from the south, rising but 30 feet above Lake Abita, but from the north it is very prominent as an isolated hill that rises 506 feet above the river flowing along its northern base.

673. "Red granite," top of Brulé Mt. and the rock is not well seen

in situ. Almost no rock but the red granite is seen along the trail from Lake Abita to—

674, a rather fine-grained deposit, with quartz, which occurs on the north face of Brulé Mt., forming a perpendicular wall about 20 feet high, but is only seen (so far as examined) a little east of but near the trail. It is 240 feet below the top of the mountain, and makes a more or less continuous jog or shoulder. Very few red pieces are to be seen north of this shoulder, but south of it they make nine-tenths of all the stones. Occasionally light-colored gneiss and granite are seen, and rarely a piece of siliceous slate, so that it seems as if here were the northern boundary of the red granite (V. No. 655).

675. In the northern face of Brulé Mt., 300 feet below the top about south from the east end of the westerly lake in Brulé river. This reddish granitoid rock forms a perpendicular wall of 60 feet in height. This contains much hornblende, thus causing it to approach the mineral characters of the dioryte No. 674.

676. At a lower level another perpendicular wall of rock is found on the north side, a little to the west of the section line between sections 16 and 17, rising about 78 feet. This rock resembles the rock No. 674, but the bluff cannot be said to consist entirely of this. Another exposure of rock like No. 676 is at the water level, on the north side of the lake mentioned. It runs under the lake, sloping south, and is, like No. 676, deeply disintegrated.

The top of Brulé Mt. is rounded and forest-covered, the ascent in all directions being very gradual, but most abrupt from the north. The only rock seen is boulders, generally of dioryte. The highest point is about one-eight mile east of the section corner (17, 16, 20, 21, in T. 63 N. R. 1 W.) and one-sixteenth of a mile south. From this place no higher land can be seen toward the east, but there is a high peak toward the S. W. six or eight miles, supposed to be Eagle Mt., a very high range visible a few miles north, afterward learned to be the *Misquah Hills*, and other hills to the west. About north of the peak thought to be Eagle Mt., is a high square-cut hill, like one of the Saw-teeth hills; but toward the S. E. is low, flat ground, probably the course of the Brulé valley*.

On the next portage northward from the Brulé river the country is a swamp, with occasional low knolls, or short ridges, the whole covered with tamarack and spruce, and the lower parts being very stony, similar to the St. Louis valley from N. Pacific Junction northward to

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*Some of these particulars were obtained of my man Mallmann who climbed a "Jack pine" eighty feet high, growing on the top of the mountain, and from it described the surrounding country.

Knife Falls, and similar to many swamps in this northern part of the State, the most of the stones here being of the rock No. 676, but with a sprinkling of red granite, as if there were still rock of that kind in place further north. Some of the boulders are banded with magnetite. At about half way to Little Trout Lake the boulders of red granite constitute about half of all.

677. A short distance further north a hill rises on the east of the trail, but near it, (about 100 feet), consisting of the rock of this number—a very fine-grained basalt, nearly black, compact. In thin section this shows a multitude of similar polarizing, rounded small crystalline grains dispersed through a ground-mass of uniform character that is apparently semi-crystalline with scattered cubes of magnetite. This would seem to make it a crysolite basalt.

But in following the trail it passes over this hill-range, which is only part of a generally hilly tract surrounding the Little lake, next on the trail, the lake itself being 244 feet above the Brule river. These hills are not large, rising about 200 feet, but the country is what may be styled hilly. The rock constituting them is of the same kind as No. 676, and of the "red granite;" large masses of the former, and many small pieces of the latter, being strewn about.

This hill extends to the Little lake, and along the S. E side, where the superposition of the strata can be made out in descending order, the highest stratum being of the "red granite." Thus: (with a dip 10 deg. S W.)

Red granite (not actually seen in place.)	
No. 678, in a regular bed of the thickness of.........	15 ft.
No. 676, porphyry with red feldspar..................	4 ft.
No. 679A. porphyry with gray feldspar...............	8 ft.
No. 680. Fine bedded, crumbling, seen.............	18 ft.

The foregoing does not include all the strata, some being invisible both at the top and at the bottom. These strata seem to belong to the formation of the great slate and quartzyte range, underlying the cupiferous, as developed at Grand Portage and along the boundary line, but here more metamorphosed.

678, is a dark (pyroxenic ?) rock, with no apparent feldspar. Fragments of a rock like this were seen on the top of Brulé Mt , evidently carried there by the drift movements, and could not be referred to their stratigraphic position. (V. 684)

679. Finely porphyritic with red feldspar, the ground mass being like the rock No. 678.

679A. The same as the last, with gray feldspar crystals.

680. A fine-grained, dark rock porphyroidally sprinked with feldspar of a flesh-red color. While this is in heavy beds in the stratification, it has a fine, rudely basaltic, disintegration, due to a structure of short joints and cross-planes, mainly perpendicular to the dip, by which it crumbles out so rapidly that it is not easy to get a fresh fracture. It is one of the shaly sedimentary parts of the so-called Animikie Group.

Little lake is 1,199 feet above Lake Superior, and about 200 feet below the surrounding hills. Little Trout lake is 1,272 feet above Lake Superior, being the highest on the Iron Trail in the traverse from Lake Superior to the boundary line.

The hill at the right of the portage from Little lake to Little Trout lake is made up of the numbers 681, 682 and 683 is downward order, with the thickness stated below: dip 20° S. E.

681, (seen twenty feet, may have more above.) A very fine, black rock, approaching aphanitic slate.

682, (35 feet) Porphyry, both with red and with gray feldspar crystals. This is a part of the great formation lying below the cupriferous, already mentioned, and is in beds of an inch, where weathered, or in heavy layers of five or six feet. The ground mass seems to be the rock No. 678. The red color seems to come from weathering, the original color being gray. This is shown in one of the small samples. It has free quartz.

683. (20 feet; there is a talus below of fifty feet in which the rock is unknown.) A fine-grained heavy dark rock, apparently consisting of triclinic feldspar and diallage with a little uralite and magnetite.

684. Further north is a layer of four feet of a fine black rock, evidently crystalline, somewhat like No. 678 or 683, included between some of the beds of the foregoing porphyry, near the bottom of the same.

From Little Trout lake to Misquah lake is a descent of fifteen feet.

685. Reddish-brown rock weathering red, with red feldspar crystals. This rock makes the Misquah Hills in the S. W. part of T. 64, 1 W. It is rudely and coarsely basaltic, the columns being perpendicular to a S. or S. E. dip. This number is from near the trail about a mile south of Misquah lake, near the town line between 63 and 64, on Sec. 32, where a thickness of fifty feet can be seen. It is bedded as well as basaltic, and in weathering sometimes shows laminae of one-fourth and one-half inch. It is undistinguishable from the rock frequently called red granite in these descriptions, but its geographical position seems to place it in a lower horizon. There may, however,

be several faulted upheavals of the same horizon, so that in going north one does not invariably pass on to lower beds, but sometimes from lower to higher.

Misquah lake* is flanked on the N.E. and E. by high brick-red hills. Some of them being 500 or 600 feet high. The trees, being nearly all fire-killed, and even consumed, allow a perfect view of the rock. It is the same as 685.

686. "Red granite" from the east of Misquah lake, Sec. 32, T. 64, 1 W. This rock is basaltified and massive, rising in mountain-like masses. It dips at a high angle toward the east.

687. The same rock as the last, brecciated or scorified, though still weathering brick-red.

These mountains are mainly to the east of the trail and so far as can be seen they are formed wholly of this red rock,

There is much drift in the form of large boulders along the lakeward side of these red hills, particularly near the lake where the trail goes. These large pieces are of dioryte, often magnetited, and porphyry like No. 682, or dark rock like 681, with many pieces of siliceous slate and gray quartzyte.

688. The character of the rock, and of the country, changes at once on entering Cross lake, which is thirty feet below Misquah lake. The rock when first seen is at the right of the entrance, and is mixed and irregular in structure, as if it had been a conglomerate originally. In general it is porphyritic with gray feldspar and has a little quartz, but the ground-mass, which seems to be the rock No. 678, varies greatly in its prevalence over the feldspar—also the size of the feldspar crystals varies. Hence the outward aspect of the weathered surface is spotted with dark and light colors, the feldspathic parts (and particularly the coarser-grained) becoming white, or nearly so, the rest being darker, or with fine mixture of dark and light. This rock has a basaltic structure, and a very heavy bedding, the latter dipping south, and the basaltic structure being perpendicular to the dip. (V. 701 and 702.)

Cross lake is a large lake, expanding in finger-shaped elongations east, west and southwest, and having several rock islands, as well as north and south. This lake and Misquah lake are tributary to the North Brulé river. The shores and the islands of Cross lake are low, made of the next numbered rock.

689. Similar to No. 688, but more uniform in structure. Evidently a gray dioryte, from the same formation as that, and much like the rock 682.

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*So called from the Chippewa word meaning *red*, in allusion to the red walls by which it is enclosed along its east shores.

The lake through which the North Brulé flows, next north of Cross lake, is surrounded by a similar low country, and has the same rock as No. 689. This also has many arms and bays running west, and from one of them is a canoe trail and portage to "Brulé river lake," which gives source to the South Brulé and to Temperance rivers.

Cariboo lake is 1,238 feet above Lake Superior, and twenty-two feet higher than North Brulé lake. Its shores are low, mainly of bare rock like 689, which however, rises in some places from ten to fifteen feet. The timber is fire-killed, or consists of a second growth of small trees ten to twenty feet high. Between this and Poplar lake is Little lake, three feet higher than Cariboo lake.

690. Near Little lake, at the north end of the portage, is a bare dome of rock, rising in the swamp about twenty feet, represented by this number. It is dark-colored, hard and fine-grained. It is not bedded, nor visibly basaltic, but all over the rounded exterior are polygonal spaces, marked out and included by bands of harder rock that rise as low ridges above the surface, fitting exactly to each other. This rock under the microscope shows its igneous origin by its composition which is plagioclase, augite and magnetite. It also seems to hold an occasional grain of quartz.

691. Gabbro, consisting of plagioclase (assumed to be labradorite), diallage and magnetite; related to the last. This is a sample of the usual "trap" of the country. It weathers light, and is in that way in marked contrast with the last, though that difference seems to be due solely to the greater proportionate amount of feldspar in this, and of augite in that. This occurs in patches on and in the last, and especially on the north side. It also seems to cross and cut it in vanishing veins.

692. Gabbro, like the last; this forms a series of bluffs along the south shore of Little lake, of about the same hight and form as the last described, but the rock is rather finer-grained than much of the trap of the country. This makes a low hill-range along the south side of the lake.

Poplar lake is 1,221 feet above Lake Superior. The rock the whole length of Poplar lake is the same as 692.

693. Gabbro; from the west end of Poplar lake, where the portage trail leaves it going to Duck lake. It rises about twenty feet above the water all about, in undulating domes, rounded as by glaciation, though no glacial marks can be seen. The country is burnt; a few foreign boulders are strewn over the bare rock surfaces.

Duck lake, by aneroid, is found to be 1,244 feet above Lake Superior, and Portage lake 1,234 feet. Where the trail reaches Portage lake is a low upheaval of rock like No. 693. The country generally is made of this rock, nearly bare. It contains in some places considerable magnetite. Mayhew lake is 1,213 feet above Lake Superior.

The same rock as 693, or some slight variation from it, continues to the entrance on Mayhew lake (or Iron lake), with increasing frequency of drift pieces of flinty quartzyte and slaty quartzyte. The trap is more magnetited in places, but, except in that particular no change can be seen.

694. Gabbro, with much magnetite; a little east of the section line, between sections 32 and 33, on the south shore of Mayhew lake (or Iron lake.) The rock here is in even and continuous beds, that dip regularly to the south, like the quartzyte and trap of the country, undulating a little up and down. This is seen in many places. It occurs also on the south shore of Portage lake. The beds vary from four inches to twelve inches in thickness, and show weather-stripes on the exterior, due to varying composition, something like a sedimentary rock. (V. No. 814.) They suggest the query whether this trap may not be due to a change, *in loco*, of the early sedimentary rocks. The great extent, the constant dip, and this regularity of bedding, and its thinness, all coincide to point to that as its origin, rather than to the overflow of molten matter over so extensive a region. The mineral composition, however, is constant, and allies it to the igneous rocks of the "gabbro range" which graduate into the trap rocks of the Cupriferous. It seems, however, that there was a vast outflow of igneous rock in the midst of the era of the quartzyte and slate group, producing this area of the "gabbro range," and separating the lower portion from the eras of the porphyries, and the red shale and red sandstone which are characteristic of the cupriferous formation proper. There are some reasons for believing that this great igneous outflow entered the sedimentaries as "laccolites" in many places, and thus tilted and modified the overlying beds, instead of being produced prior to their deposition.

695. Magnetic ore, S. E. ¼ Sec. 36, T. 65, R. 3 W. on the north shore of Mayhew lake (also known as Iron lake.) This rock is a condition of the trap of the country, and is almost entirely made up of magnetite. A careful study of this location warrants the following generalized statements:

(1st.) The ore is in the igneous rock.

(2nd.) It varies in quality very much, even passing into rock that cannot be styled iron ore.

(3rd.) It involves with itself nodules of coarse gabbro containing considerable magnetite.

696. Sample of this nodular or concretionary rock embraced in the iron ore.

(4th.) It also embraces isolated pieces of gray quartzyte (apparently), but which in thin section are seen to consist of plagioclase, magnetite and augite; and some dark, crystalline, micaceous nodules.

697. Samples of the dark and micaceous nodules. These dark masses embrace dark labradorite (?) biotite, hæmatite, with viridite.

698. Samples of what appears like a granular, gray quartzyte, but which really consists of the minerals that go to make gabbro. This is distributed through 695 in rounded lumps like some masses of No. 696. Some masses of No. 698 are very large, where they occur on the north side of the swamp.

(5th.) It dips toward the south in beds whose aggregate thickness is at least fifty feet, but may be seventy-five feet, the actual amount being hid by a swamp.

(6th.) It involves also detached masses of coarsely crystalline gabbro nearly free from magnetite, but containing biotite.

(7th.) It sometimes gives place to a coarse trap of the same kind which is so large in amount as to constitute the rock of the place, and its connection with the ore cannot be seen.

699. Samples of this coarse, micaceous trap.

(8th.) It lies on a fine-grained rock like No. 698, which is a fine gabbro with chrysolite, resembling a fine, granular, gray quartzyte. This rock dips, so far as any dip is discoverable toward the north, and it seems to have furnished the rounded masses of No. 698 embraced in the iron ore. The northward dip is due to a deceptive appearance of columns of basalt.

700. Samples of this fine chrysolitic gabbro. This rock much resembles the chryrolite basalt No. 677.

(9th.) In seams and gashes in No. 698, the rock No. 699 is also found.

(10th.) The iron in considerable, but unknown quantity, is of fine quality, being seen in other places besides this described.*

West from this iron location, after passing the little bay running E. N. E. the north shore of the lake is made up of No. 699, which appears massive, weathers lighter than the trap usual in the country, and appears like the "Rice Point Granite." It is hard and firm, and rises in domes which rarely show any dip. At one-fourth mile west of the little bay it is broken by the lake and ice in winter and over a small area shows both a horizontal jointage, and one which has more the characters of dip to the N. 45 degrees—the latter having the planes of separation at varying intervals of six to eighteen inches, and marked also by a lighter weathering, or by a pinkish stain in the feldspar. This, however, may be the remains of a former basaltic structure.

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*This iron ore constitutes what is locally known as the "Mayhew Iron Range," and is found in a belt about a mile wide on both sides of Iron lake, and on the south side of Portage lake, and between Portage and Poplar lakes. An analysis reported by Mr. Hause, performed by R. S. Robertson of Pittsburg, Pa., gave the following result: Silica, 2.02; Alumina, 2.68; Titanium, 12.09; Sesqui Chromium, 2.40; Mag. ox. Iron, 80.78; Lime, trace, phos. acid, 0.03.

701. The rock last mentioned, resembling the "Rice Point Granite." It consists largely of a gray feldspar, is firm and massive and rounded. It also has diallage and magnetite, with occasional scales of biotite.

702 is embraced in pockets and lumps in No. 701. It is the same rock, but with much coarser crystals, and a larger per cent. of diallage (V. No. 688 and No. 1 D.).

703. Sample of iron ore at the east end of Pewabic Island containing all the ingredients of the rock, even mica. There are three or four other islands in the west end of Iron Lake. The iron here is plainly embraced in the rock 701, which is also the same as No. 696; which is the same as the rock styled trap or gabbro all the way from the south side of Little Lake. This rock of course has variations which account for its different aspects, but in all these it does not depart from the accepted characteristics of an igneous rock. Its variations are included within the range of mineral associations possible, by relative changes, in plagioclase (probably labradorite), chrysolite, augite, magnetite and it has as accessories biotite, hæmatite and a green mineral that may be derived from a decomposition of the augite, which is also frequently in the condition of diallage.

About a mile west of the end of Mayhew Lake, on the town line, is an isolated knob of the same kind of iron ore, in low ground, "30 links wide, all solid iron," so reported by Paul Morrison.

704. South of the little island crossed by the E. and W. town line, in Mayhew Lake, the rock is highly magnetited. It is also micaceous. It has plainly a dip to the south of about 25°. The jointage here is also somewhat like the apparent dip seen on the north shore four miles west of the little bay. A similar deceptive jointage resembling a N. dip is to be seen at the portage to Loon Lake, the general dip being to the south.

705. Appears like a metamorphic rock, bedded and dipping north about 45° at a point a little back (N.) from the shore, a short distance west of Mayhew's location, which underlies the iron-bearing rock, and the iron ore, and has been styled changed quartzyte. It really is a

crystalline, fine-grained rock which has hornblende changed to viridite, feldspar and magnetite, and its apparent northward dip is due to a fine basaltic jointage perpendicular to the true dip, which is about the same in degree toward the south (V. No. 700). No. 705 has a visible thickness of 10 feet, and the overlying iron rock has a thickness of about 20 feet.

706. Through the iron-rock at the location 705 run seams, three to six inches in thickness, of pinkish rock consisting of quartz, orthoclase and hornblende, in rather fine grains. These seams and veins are parallel with the basaltic jointage of the rock No. 705. Sometimes a pinkish shade of color runs into the trap, accompanied by quartz. These pinkish beds and seams, which simulate planes of bedding are probably due to contact with the underlying formation and nfusion from it.

707. In some places in the trap, where one of these red seams passes through it, the hornblende which accompanies the red rock, greatly predominates, or is very coarse, and sometimes is fibrous and radiating, coating the walls of the seam. In such places mica also can be seen, and also, mixed with the fibrous hornblende, occasionally a crystal of quartz.

Nearly everywhere about the shores of Mayhew Lake the rock is trap, or gabbro, but generally with more magetite than usual.

708. On the portage north from Mayhew Lake to Loon Lake, the rock No. 705 first appears, with a southerly dip. Then, after a low space another ridge succeeds, showing the rock No.708, similar, if not identical with No. 705. This belongs to the great quartzyte and slate formation, or the "Animiki group." From the top of this ridge the descent to Loon Lake is sudden, and amounts to 150 or 175 feet.

709. This is a range of high hills along the south side of Loon Lake, and between the bay and the lake, the top of which are made up of rock of this sample, which is like No. 708, having a thickness of 80 to 90 feet. This has the outward aspect of trap and perhaps has been designated trap in former instances, but it is to be distinguished from the igneous rock that has been described. Under the microscope in thin-section it consists of a triclinic feldspar, and some orthoclase, changed (or viriditic) hornblende, magnetite, and a small amount of quartz—a kind of dioryte. Its affinities with the great quartzyte and slate formation are evident, and it seems to have resulted from a metamorphism of the upper part of that formation. It is that which underlies the iron-bearing trap of Mayhew Lake. It is in heavy layers 4 to 10 feet thick, and has a coarse, perpendicular jointage that makes it

appear basaltic. It stands in perpendicular escarpment facing north and west, making the tops of the highest hills. It probably has not everywhere been kept distinct from the true igneous rock or gabbro which constitutes a heavy stratum lying over it. (V. under No. 300.) This is taken from the hill near the base of the point separating the bay from Loon Lake.

710. Dark, homogeneous, finely crystalline, heavy rock like No. 684, underlying No. 709 in the same bluff, 5 to 10 feet in thickness. This is in beds 6 to 10 inches thick.

711 and 712. The rest of this hill is made up of alternations of these rocks, altogether making a thickness of 100 to 125 feet, down to the level of Loon Lake. The former constitutes about nine-tenths of the whole. It is black, and grayish-black, in beds from 4 to 40 inches, very fine-grained, sub-crystalline, with a felted polarization, having a conchoidal structure. The latter is of the same color but more coarsely granular, is in beds of 1 to 3 inches, and is slaty in the direction of the dip, which is S. and 10° to 15° in amount, but in other places the dip amounts to 20 degrees. This hill is only one of a series of northward-facing bluffs which extend from some point in Canada as far west at least as the west end of Gunflint Lake, and produce a sudden shoulder in the surface contour. The actual highest divide, or *Mesabi* is usually a few miles further south, and is apt to consist of the gabbro rock. While there is a sudden descent northward from the face of these bluffs, amounting to 300 or 500 feet, the general level toward the south ascends to the top of the Mesabi, though sometimes there are two or three interrupted lines of similar northward-facing hills before the Mesabi is reached.

The country along the north of Tucker Lake is low, and occupied with magnetited trap, and this character continues southwestwardly some five or six miles further.

713. From the north shore of Tucker Lake, a magnetited gabbro, embracing also masses of rock like No. 702.

On the south side of Tucker Lake is a long range of hills rising about 100 feet, constituting the red Mesabi, though the whole tract between Tucker and Loon Lakes is also on the height of land for this region.

714. Gabbro from the hill range south of Tucker Lake, in the N. part of Sec. 10, T. 64, 3 W.; being the Mesabi in this part of the State. This is the same rock already described as constituting the low shores of Poplar and Iron Lakes (Nos. 693, 694 and 701). Between this hill range and Tucker Lake are several lower ridges of trap

rock. South from Iron Lake the "red rock" begins again in about six miles, according to Paul Morrison.

Duck Lake is 1,244 feet above Lake Superior. Poplar Lake, which is large and long E. and W., has numerous islands, resembling Saganaga, except that here they are of diroyte and gabbro instead of granite

715. From an island in Poplar Lake, near the portage coming from Little Lake. The usual rock about Poplar Lake.

Hungry Jack Lake is 1,069 feet above Lake Superior by this series of aneroid connections. Last year this lake was ascertained to be 1,200 feet above Lake Superior by series of observations from Grand Portage, making a disagreement of 131 feet (see the ninth annual report, p. 78, where this lake is distinguished as a "lake south of Birch Lake"). If this is all due to erroneous observations of the Iron trail south from Grand Marais, the elevations given along that route should be increased somewhat. The error is more likely to be in that route than in the boundary line route.*

716. Trap-rock, from the top of the "stair portage" which connects Duncan's Lake with Mud Lake. This forms a high basaltic bluff facing north, a little west of the portage.

717. Trap-rock from the north side of South Lake, opposite the town line between ranges 1 and 2 west. The north shore of this lake is low, and glaciated S. W. and N. E., and the south shore rises into high hills containing, presumably, the rock No. 716, at the top.

718. Fine trap-rock, south side of Gunflint river, a little east of the location of No. 305 last year. This runs obliquely down to the river, and under the water, in angular basaltic blocks like trap, presenting a face (back in the woods) toward the north much the same as the highest bluffs of the country.

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*Mr. E. Le M. Hoare carried a series of aneroid elevations from Grand Marais to Iron Lake for railroad purposes, and found the highest point on the line to be 1.190 feet. His route is shown on Plate II. This height was reached in S. W. ¼ Sec. 26. T. 63, north of the Twin Lakes From that point there is a very gentle, undulating descent to Iron Lake, along his route, which was found to be about 1,175 feet above Lake Superior, or 38 feet lower than by the observations of the geological survey. His profile shows a nearly level grade from the highest point southward to a point about a mile and a half north of the Devil's Track river, where a descent begins. The crossing of the Devil's Track river is 1,015 feet above Lake Superior. For the next two miles and a half the descent is 150 feet per mile. Between two and a half and four and a quarter miles from Lake Superior the grade is 165 feet per mile. and below that it is 147 feet per mile. The crossing of the South branch of the Devil's Track river is 655 feet above Lake Superior. By spirit-level and rod a point was fixed on the S. E. ¼ Sec. 13, T. 61 N., at the crossing of the creek, which had an elevation of 1,080 feet, and by the same means Devil's Track Lake was found to be 1,025 feet, or 39 feet lower than by the observations of the geological survey. Mr. Hoare states that numerous magnetite boulders are scattered over the country between Grand Marais and Iron Lake which produce marked local disturbances of the needle, and that there is evidently a deposit of iron ore at some point between Sec 5, 61, 1 E., and Devil's Track Lake. From several assays Mr. Hoare states that he ascertained the iron and titanium together in the ore from Iron Lake to be pretty nearly uniform throughout. but that the titanium varied from 6 to 13 per cent., displacing about the same percentage of iron. The ore is in enormous quantities, in one place laid bare so that he crossed over it 30 paces. Another deposit of magnetic Iron was assayed by him, located "close to Poplar river and near Lake Superior," which produced 38 p. c. iron, 1.53 p. c. manganese, and .05 of phosphorus

719. Trap-rock, having a jointed, or basaltic structure, from the easterly of the two points that enclose the little bay on the south side of Gunflint Lake into which the portage comes from Loon Lake. This point rises about 75 feet. The top, represented by this rock, containing augite, plagioclase, magnetite and a little hornblende and quartz, is of the rock that usually forms the tops of the high mono-clinals of the country—a dioryte trap, perhaps a metamorphic condition of the beds of the great quartzyte and slate formation. It faces the lake and has a high talus of fallen blocks.

720. The rock of the westerly of these points, almost identical with No 718, essentially the same rock as 719, presenting a walled face toward the north, much jointed, or finely basaltic, rather finely crystalline, but rising but 10 feet above the lake. Thus it appears to make no difference at what horizon samples are taken from the "quartzyte" formation, if they only come from the *top beds* at the place they are obtained. They are always "changed quartzyte," or trap, so-called. Slate can be got only at a depth of 75 to 100 feet below the top. It seems as if any and all the beds are subject to this metamorphism when they happen to be superficial, unless these be unknown and unsuspected irregularities in the stratification. Hence, even at the very northern edge of the area covered by these mono-clinals, the changed rock, or trap, whichever it be, lies within a few rods of, and nearly on the same level as the talcose slate and syenite, as along Gunflint river.

721. A careful section of the hill was taken, lying a little east of the portage trail from Gunflint Lake to Loon Lake, on Sec. 26, T. 65, 3 W., for the purpose of ascertaining what relation might exist between the basaltic beds which always lie on the tops of these hills and the slaty layers that compose them toward the bottom, with the following result: No. 721, forming the top of the hill is 75 feet thick, and like numerous other samples already noted, viz., Nos. 308, 705, 708, 709, 719 and 720. The hill is 250 feet high.

722. Obtained about half way down the perpendicular portion of the bluff. The same as the last, but finer-grained. It has also a darker color. It embraces apparently triclinic feldspar, magnetite, orthoclase, viridite and a little quartz. It also shows an occasional grain of pyrite and of dichroic hornblende.

723. A dark, or gray, homogeneous rock, in general character similar to the last, though of a finer grain, resembling very much the rock No. 683. It has pyrite, and much of the magnetite is arranged in branching, foliage-like tufts, which can be seen in a thin section, from near the bottom of the perpendicular part.

724. One foot lower in the bluff than the last. Undistinguishable from the last.

725. Six inches lower; same rock but finer. This is hard, fine, dark-colored.

726. A foot lower; the same rock but finer, and tending to a slatiness.

727. Four feet lower; slate, fine, black or nearly black, of the kind commonly seen in these bluffs. The rest of the bluff is much hid by talus, but so far as can be determined consists of rock like 727. A hundred feet lower, and but a short distance north from the foot of this bluff was obtained No. 720, forming the top of a lower ridge of rock.

The transition from the basaltic rock, or trap, forming the top of this hill (No. 721) to the slate of No. 727, is more abrupt than on the south side of Loon lake; but there is still here an imperceptible transition. There is no suddenness about the change, nor break in the bedding to indicate the former fluidity of the top of the hill. The change is complete in the space of four feet—from basaltic columnar structure to perfect, horizontal, or southward dipping slatiness. If the basaltic portion is due to igneous origin there was such a transfusion of mineral characters, and such a perfect cementation between it and the slaty portion that no line of separation where the igneous portion was superimposed on the sedimentary, can be designated.

A second visit was made to the locality No. 312; on the north side of Gunflint lake, where the flint beds appear in outcrop, about half a mile east of the outlet of the lake, at which the following conclusions were reached:

1st. The rock is a breccia in which the flint, generally black, or dark jasperoid, appears in a gray rock which weathers rusty, in angular pieces of all sizes up to two feet, or even makes continuous beds more or less tilted and broken. Sometimes also the gray rock that weathers to a rusty color on the beach is in angular pieces or patches in a mass of angular pieces of non-rusty gray rock; and sometimes the two alternate in parallel bands as if so deposited as sedimentary beds at first.

2nd. The formation, as it is, is tilted into the lake, southward, at an angle of perhaps ten degrees, on an average, though there are places where the dark jasperoid layers seem to stand nearly vertical.

3rd. The whole formation is rudely basaltified in small columns.

4th. The thickness visible, in an interrupted series of outcrops, seems to be about twenty feet.

5th. A little distance further west, and near the extremity of the point before reaching the "narrows," the exposed rock is slate again, at first horizontal, and then with a dip of eighteen to twenty degrees to the N. E. then S. again; becoming hid by trees the rock terminates, and the point too, the elevation of the hill being forty to fifty feet.

The close proximity of this flint and jasper locality to the next great underlying formation (syenites and slates) makes it one of great interest to the geologist, but so far as scrutinized, as yet the true relation of the two formations are not revealed by anything here seen, though there seems to be an unconformability between them. At the "narrows" is basaltic trap rising in characteristic bluffs and striking E. and W. with a face toward the north.

728. Rock of the island in Saganaga lake nearest the inlet from Gunflint lake, on the south side. This is a syenite with mica, containing much coarse quartz. The feldspar is orthoclase, of which the greater portion is white, but some of it is flesh-colored. It is a beautiful, light-colored syenite, suitable for ornamental purposes. This rock prevails about Saganaga lake, but also becomes darker by an increased amount of hornblende.

729. Syenite from "Cariboo narrows" N. E. ¼ Sec. 19, T. 66, 4 W. Gull river and lake may be ascended by course to near the S. W. cor. of T. 66, 4, without portage, by passing two rapid places. Gull lake is thirty-nine feet above Saganaga. A portage is necessary at the third rapids. Gull lake is similar to Saganaga in having numerous islands based on a light-colored syenite.

W. Gull lake, which is united by a short rapid stream to Gull lake, is twelve feet higher, and is filled with the same sort of rocky islands.

730. Syenite from the rapids between Gull and W. Gull lakes.

Along the south side of these lakes, distant about two miles, runs a range of mountains which seems to be a continuation of that running west from the south shore of Gunflint lake, marking in general the northern limit of the slate and quartzyte group.

731. The rock 730 continues to form the islands and shores of W. Gull lake to near the point where the stream from Frog-rock lake enters it, near the southwest end, where the rock 731 takes its place, rising in little hills of very similar contour and size, some of each rising 50 to 100 feet. This rock is very tough, greenish, has in general an imperfectly schistose or fibrous structure, is seamed and jointed finely, some of the seams being filled with a fine-grained, siliceous, nearly white rock, or pinkish quartzyte, which is faulted frequently by other seams, making a zigzag network of joints and seams. Some of these

seams are of a pinkish color, and six to ten inches wide. But they are themselves broken and often entirely diffused and lost. The rock is not slaty, but separates under the hammer into rude rhombs. It is fine-grained. (V. Nos. 348, 355, 356, 358.) This rock in thin-section shows a matrix which is homogeneous, transparent, penetrated by the other minerals, and between crossed Nicols has a neutral color, darkening on rotation of the stage, with the quick limpid change characteristic of quartz, but not having its brilliancy. The other chief mineral is green fibrous hornblende, but it is so changed that it is rarely dichroic, and is often more like serpentine than hornblende in its optical characters. There are also a few grains of some triclinic feldspar. This composition seems to make this rock an amphibolyte. In land specimens it is not distinguishable from the amphibolyte of Littleton, N. H.*

The stratigraphic relations of 730 to 731 are not easy to make out. Sometimes they lie immediately in contact, the plane of separation being perpendicular, and sometimes they are in separate knolls, or hills, contiguous, the contact of which below the soil is not visible. In general the hills composed of the amphibolyte are higher and rougher than those of the syenite.

732. Light pinkish granulyte, or quartzyte, embraced in veins in No. 731.

733. Frog-rock lake, which is next west of W. Gull lake, is so named from the Chippewa word which signifies *spotted* or *greenish*, from the appearance of the rocks, and it is seventy-three feet above Saganaga. The mineral which gives green color to the rocks of this region appears sometimes in thin seams or in coatings on opened seams, as shown by the samples of this number.

734. This greenish rock in some places is very fine and tough, and also porphyritic.

735. At the very entrance to Frog-rock Lake is a hard, massive, speckled dioryte that forms a little fall where the water goes out of the lake In passing the portage, white quartz is seen in pockets in this rock (731 and 734) sometimes having perfect crystalline terminations.

736. From an island in Frog-rock Lake, about half a mile southwest from its outlet; a green amphibolyte (?).

737. A talcose or chloritic rock, having a coarse perpendicular schistose structure, from the rapids between Frog-rock and Town Line Lakes, northwest from Frog-rock Lake. This is conglomeritic, some of the pebbles being six inches across and like the gray amphi-

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*No 216, of the "typical rocks of New Hampshire," or No. 3,016 of the Museum Register.

bolyte (No. 731). There is in it also considerable pyrite. The pebbles are rounded, and are intimately connected with the matrix. There may be thirty feet of this here visible, including that below the water and above. There seems to be a S. dip of about 10 to 15 degrees. The aspect of the country changes at once on entering on this conglomerate. There are no bald, rocky hills to be seen around the Town Line Lake, but the trees grow all over the rock, and down to the water. The level of this lake is 83 feet above Saganaga, and King-fisher Lake (or Ogishki Muncie) is ten feet higher. The rapids connecting them are formed by the same rock (737).

738. A fine, firm conglomerate, or grit, containing considerable pyrite which changes to iron oxide near the surface The grains are mainly of quartz, as well as of flint and feldspar. Some of the flint is black, and two inches across. This rock recalls the Gunflint beds. It seems also that the rock 737 is a part of the same conglomerate as 738, but at a lower stratigraphic horizon. It hence seems as if the Gunflint beds, which are the lowest part of the quartzyte and slate series (the lower volcano of Logan) pass by a common metamorphism through the perpendicular slaty, or schistose structure into the slates of the Huronian—but whether at first conformable to them or not, cannot be said yet. This rock (738) does not continue far west of where it appears, which is near the N E. end of Ogishkie Muncie Lake, on the south shore. It stops at the first narrows, at the east end of the lake apparently jogging off south suddenly, since the rock 731 sets in in full force on the south side of the lake on the W. of these narrows, and continues to one-half mile west of the section line between sections 13 and 24.

739. At one-half mile W. of the section line; somewhat quartzyte, firm and resembling 738. This occurs suddenly in No. 731, and it weathers into large angular blocks, while No. 731 is apt to weather out in rough schistose fragments.

Directly across the lake, on the north shore the rock 738 can be found again appearing in a similar manner as on the south side, *i. e.*, in a bluff and hill near the lake, but 731 appears soon on the south side, and with sundry variations forms the south coast to the peninsula on the south shore crossed by the line between Secs. 23 and 26 which is made up of the quartzyte and slate, having a dip to the S. S. W. of about 80 degrees. The slate alternates with the quartzyte beds, the former being in layers generally of two to three inches, and the latter in beds of six inches to two or three feet. There is in the slate, which is slaty in the direction of the true bedding, also a tendency to slatiness E. and W. perpendicularly, so that the beds are apt to separate, when struck, both in the direction of the true bedding and along the weathered planes of the E. and W. slatiness, making thin lenticular wedges. This E. and W. slatiness is not visible in the quartzyte. The same alternation of slaty and non-slaty beds is to be seen on the S. shore of Vermilion Lake, and at Thompson.

740. Slate from the above.

741. Quartzyte from the above. This is much like No. 738.

742. Dyke-rock, from a dyke cutting the great conglomerate of Ogishkie Muncie Lake, N. W. ¼ N. E. ¼ Sec. 26, T. 65, 6 W. Plagioclase, magnetite, chrysolite, a little hornblende (?), a little quartz pierced by spicules of apatite and pyrite. This dyke is six and a half feet wide and runs E. 10° S. It crosses a little peninsula, and on both sides disappears below the water of the lake. It is a dark, heavy, firm rock, not differing from numerous others seen crossing the great quartzyte and slate formation.

743. Calcarcous, rusty schist, apparently talcose, and overlying the next; this has a strong resemblance to the conglomerate schist No. 737. It is coarse, and seems to disintegrate more readily than any of the rocks of this region. It is in the lower places. It has no evident dip, or bedding, but a schistose structure running E. and W. perpendicular.

746. Associated with the last is a grayish marble, which may also contain siderite. They are in the N. E. ¼ N. E. ¼ Sec. 26, T. 65, 6 W. The marble rises in an inconspicuous low ridge, in a valley. It is coarsely jointed, and has an apparent dip toward the south of about 10 degrees, and is 22 feet thick.

744. From the great conglomerate, but showing one of the indeffinite conditions of the same. The conglomeritic character is hardly distinguishable on a fresh fracture of the rock which sometimes shows different shades of green. But all over the surface, when glaciated and weathered, are visible the forms of rounded boulders, included in the rock, the different colors and grain of the boulders being brought out plainly. This is essentially the same formation as the rock 743 and 737, and it constitutes by far the greatest part of the country rock about Ogishkie Muncie Lake. Wherein the rock 737 differs from 738 which also passes into 744 by the accession of slaty structure and then the obliteration or modification of it by the accession of boulders, it may be ascribed to varying proximity to and influence of the underlying "talcose" rocks in the process of deposition and metamorphism. The rock 744 forms the little island in the central narrows of Ogishkie

Muncie Lake*, near the peninsula crossed by the line between sectinos 23 and 26, and the mainland south and north. On the island, it is a real conglomerate, with a smoothly glaciated surface, and the sections of some of the rounded stones are a foot and even more in diameter. They are very abundant. Sometimes the rounded stones make three-quarters of the whole rock, but in other cases the slaty matrix is nearly free from them, over considerable areas. The general surface rises in short, zig-zag ridges which, though often entirely bare, have boulders and a thin soil of clay and mold in the valleys between them, so as to obscure their inter-relations. In these valleys are a multitude of fallen, half-burnt trees, among which are growing small birches and willows (V. after 752).

There is a sudden change in the direction of strike of the rock of the country, in the N. E. ¼ of Sec. 26, from nearly E. and W., to N. and S. At the shore on the peninsula in Sec. 23 it is the same as the slates generally seen in the Huronian, in this part of the State, but after passing the valley in which are the calcareous schist and the marble, it is N. and S. That the change is somewhat sudden is shown by the fact that the beds running N. and S. are seen to cease abruptly and to be replaced by the conglomerate in a number of places. The conglomerate in these cases is, so far as seen, rather finer than the average.

745. Slate and quartzyte, from the rock that strikes N. and S. (as above), showing the bedding of sedimentation, the tendency to E. and W. schistose structure, and the jointage to which the whole is subject.

746. (See before 744.)

747. Directly south of 745, (on the lake shore) *i. e.* in the S. W. ¼ S. E. ¼ Sec. 26, is the hard, black rock represented by this number. It is a kind of black quartzyte, or flint, the dip of which cannot be stated. It is finely jointed or broken, nearly at right angles transversely, occupies the area of a small ridge near the shore.

748. On the portage from Ogishke Muncie lake to Dyke lake, which is a little lake southwest from Ogishke Muncie in S. E. ¼ Sec. 28, is a siliceous slate, standing vertical. It is cut by a dyke running about N. and S. thirty to forty feet wide.

749. Rock from the above dyke; dark doleryte.

750. Conglomeritic slate. This passes into the slate 748. It shows no bedding. From the north side of Dyke lake.

751. S. E. ¼ Sec. 30, T. 65, 6 W. north of the east end of Caca-

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*With one exception this is the only island which has its forest yet standing; most of the country being utterly destitute from fires.

quabie lake, is Mallmann's Peak. It extends rather as a lower range toward the N. E. half a mile, terminating at the end of the lake in the northern part of Sec. 29. This rock is a peculiar porphyry. The ground mass is amorphous, and the disseminated crystals are hornblende. It is unlike any thing before seen.

752. A dyke forty feet wide, represented by this number, cuts the last. This is a doleryte with considerable magnetite and pyrite.

Further examination of this great pudding-stone on the high peninsula that projects from the north shore of Ogishke Muncie lake, on Sec. 23, shows that it is crossed by E. and W. bands due to sedimentation. These bands stand nearly or quite vertical. They are similar to those seen in the quartzyte and slate, but are coarser and more indistinct. They are seen in the finer parts of the pudding-stone, when the rock passes into a fine conglomerate or coarse quartzyte.

On this peninsula nearly one-half of the pebbles in the rock, large and small, are from the Saganaga granite. Next in frequency is a variety of greenish pebbles, apparently from the same formation, or at least from the rock 731, and some like the dyke rock 742. Next comes quartzyte, which is sometimes gray, sometimes white. These graduate into white and gray pebbles, some of which are also black and very fine, like flint, having a short conchoidal fracture. Some of these last are banded like the jasper and flint of the gunflint beds. One banded piece of black-gray flint which was noted was a foot across. These various pebbles weather into a variety of colors making the face of the bluff perfectly spotted and mottled. The conglomerate is a part of the slates of the region, and is interbedded with them.

About three-fourths of a mile north of the central narrows of the lake, the conglomerate, which continues all the way, with a dip S. of 80 or 90 degrees, (sometimes varying a little to the S. E.) contains large, rounded pieces of the "Saganaga granite," which proves the greater age of that granite, and the unconformability of this slaty conglomerate, and the beds that are its equivalent elsewhere, upon that older formation. Some of these large pieces of syenite are over two feet in diameter. The conglomerate also here contains red jasper.

At about a mile north of the narrows the red jasper becomes very common, some pieces being six to eight inches across on the face of the rock.

At about a mile and a quarter north of the narrows the conglomerate becomes finer and finer, and the slaty bedding comes in, the whole being converted to 740 and 741, and at once the hills rise in a rude range, broken by off-sets, to the height of 150 or 200 feet higher than the general level. The highest hill is about in the center of the S. W. ¼ Sec. 14, and the top consists of the rocks 740 and 741, passing to 731, with vertical bedding. The strike of the northern limit of the conglomerate is S. 35° W. and at about one and one-fourth miles N. of the central narrows. Through the whole of this distance the dip is nearly uniform (80° to 90° from the horizontal); and by the construction of a right angled triangle a calculation will make a thickness of 6,574 .8 feet, for the conglomerate on the north side of Ogishke Muncie lake, and there may be as much more on the south side.

753. Is an average sample of the most of the hill on S. W. ¼ Sec. 14, T. 65, 4 W. (as above.) It represents a vast amount of rock in this country, since much, even of the conglomerate, is of similar rock. This here is banded with finer beds, approaching slate, which, when favorably weathered, falls to pieces as slates, though very siliceous.

From this hill the mountain-range on the south side of Ogishke Muncie lake can be seen to extend east as far as the eye can distinguish, and probably to Gunflint lake. The point of observation is E. 33° N. from Mallmann's Peak. Part of Knife lake is W. S. W. Toward the N. W. is a lake one-fourth mile away. East 33° north, is another small lake one-fourth mile distant, and at the foot of the hill S. is another little lake. Toward the north is a similar tract of country, burnt over, running to Otter Track and Knife lakes, made up (probably) of the rock No. 753, as no such conglomerate was seen along there last year.

754. Jasper conglomerate, one mile north of the central narrows of Ogishke Muncie lake.

The "Gunflint beds," south of Gunflint Lake, (V. after No. 747) have been associated with the slates and quartzytes of the overlying formation, rather than with the talcose slaty beds underlying (V. 426) but observations about Town Line and Ogishkie Muncie Lakes seem to indicate that they are here a part of a schistose, slaty formation, highly inclined, which belongs to the Huronian, passing into the great conglomerate of Ogishkie Muncie Lake.

So far as can be determined by the observations made, the following statement of the order of superposition seems to be warranted, in descending order (V. after 551).

1. The nearly horizontal quartzyte and slate formation composing the hills of the Grand Portage and the International boundary as far as Gunflint Lake.
2. The coarse grit or fine conglomerate, No. 738.

3. The Jaspery and calcareous beds that are known as the "Gunflint beds," Nos. 737 and 743.
4. Gray marble, No. 747.
5. The tilted, slaty conglomerate, and the great conglomerate, about Ogishkie Muncie Lake, Nos. 744, 750 and 754.
6. The amphibolyte and the chloritic slates, Nos. 731, 753, 348, 349, 350, 355, 356 and 358.
7. Mica schists, and alternations of mica schists and syenite, Nos. 335, 337, 339, 401, 406, 408, 414 and 417.
8. The syenites and granites of Saganaga and Gull Lakes.

There is yet one very important, undetermined question relating to this generalized section which ought to be borne in mind, viz : Is the great quartzyte and slate formation of the international boundary (No 1 of this section) the same as the highly tilted, slaty and quartzyte formation which passes into the great conglomerate? (No. 5.) There are some considerations which seem to imply that it is, though in all descriptions and sections they have been treated as different terranes. (a)Where the horizontal slates approach the syenites at the east end of Gunflint Lake there is nothing to be seen of any beds representing the tilted slates. The syenites and their associated schists come on at once. (b)Where the tilted slates and the conglomerates associated with them are traceable from the syenite upward to the gabbro as south of Ogishkie Muncie Lake, there is nothing to be seen of any beds like the horizontal black slates of No. 1. (c)The "Gunflint beds" appear to belong to the horizontal slates of the international boundary at Gunflint Lake, but their supposed equivalents at Ogishkie Muncie Lake belong to schistose and tilted slates and conglomerate. (d)Although the horizontal slates and quartzytes of the international boundary strike west and southwest across the State, forming one of the most important topographical features of the northern part of the State, and can be followed for many miles as such, yet they are lost entirely in the region of the upper St. Louis, and the tilted slates are the only ones seen where that river cuts the rock at Knife Falls and below. (e)The great gabbro belt, which surmounts the horizontal slates along the international boundary, and prevails to the east and south of their line of strike, is seen to pass to the west of Lake Superior, at Duluth, and to disappear from sight suddenly between Duluth and Fond du Lac as if its continuance depended on the maintenance of the horizontal formation with which it is associated. (f) Where the Gunflint beds become a jaspery hæmatite, as south and east of Vermilion Lake, the structure of the tilted slates passes into the iron ore as if of the same formation. (g)The formation which underlies the cupriferous at Fond du Lac is the tilted slates, and that which underlies it at Grand Portage is the horizontal slates.

A thorough examination of the hill-range between Gunflint and Ogishkie Muncie Lakes would probably reveal the facts as to any transition from the horizontal slates to the tilted slates.

In going south from Ogishkie Muncie Lake toward the mountain range, so as to strike the summit on Sec. 34, the dip and strike of the rock are seen to change several times. At the shore is a fine conglomerate, then quartzyte and slate in contorted bedding, then the same with a dip east, then the same with a dip northeast, then south, then coarsely arenaceous without any distinct dip, apparently once broken, then vertical with strike N. and S. South of the crossing of the creek, about half way from the lake to the summit, the rock is very confused (apparently brecciated and recemented), and the bedding cannot be made out. Then the dip is west, verging to southwest.

Although this is not all conglomerate, on close examination it seems to show in the field such variation as can be referred, very much of it, to an original conglomeritic condition. In approaching the summit this condition is less and less apparent, the stones gradually losing their identity in a common, more homogeneous mass.

South of the foregoing interrupted series of hills, occupied by the changes described, all pertaining to the conglomerate—quartzyte—slate formation, is the first ridge. The rock is rounded and smoothed by glaciation, though the direction of movement cannot be ascertained by any preserved striæ. There is a sudden change in the character of the rock of the hill in passing to the ridge.

755. The rock of this ridge is a greenish, tough rock, much like that of No. 731 in outward character, rather fine-grained, has numerous quartz veins and seams, and forms a large area and ridge on the mountain side. While outwardly it appears like No. 731 it has the mineral composition that more resembles a dark, fine dioryte (V. 684 and 678).

756. Passing further south, crossing a valley, another ridge is met with, rising higher, consisting of this rock—a coarsely crystalline dioryte, with a little quartz and magnetite, the hornblende being changed to viridite. It is cut by—

757, a gray, rather fine, trap-rock, in a dyke running N. W. and S. E., six feet wide.

Further south is another higher, bare ridge, broad and smooth, constituting the top of the mountain. The rock is—

758, a "trap" of a greenish color.

759. Occurs in patches in No. 758 and is like No. 756, but contains so much magnetite as to appreciably increase its weight. This is from the summit south of Sec. 35, about one fourth mile.

Of the rocks constituting the mountain east of Twin Peaks, Nos. 755 and 758, are the chief mountain-making rocks, and No. 758 is the most important, spreading a great distance still further south (judging by the form and color of the hills in view), and also probably a great distance east. Indeed, it is probably the rock that constitutes the divide, south of Gunflint and Tucker lakes, this range being visibly a continuation of that.

In passing from Ogishkie Muncie lake directly to Twin Peaks, the following observations were made by Mr. Mallmann. After a space of conglomerate, perhaps one half a mile, there is a gorge in which a creek runs S. 30° W., the rock over which it passes being—

760. A light siliceous marble, or calcarous quartzyte, undistinguishable from the marble, No. 746. On either side of the gorge is a wall of rock. On the west is conglomerate, and on the east is No.

761. which is a pyritiferous, dark aphanitic rock, one of the conditions of the slate of the slaty conglomerate.

762. Is from a trap dyke cutting the conglomerate, about one fourth mile from the lake.

South from the gorge is more conglomerate and quartzyte, then a ridge, or a succession of benches rapidly ascending. The first bench, 20 feet high, has regular bedding, and dip toward the south, but no basaltic structure. It consits of No.—

763. Which is apparently closely allied to No. 755.

764. In a higher ridge is this rock, which is the same as 763.

765. The top of the Twin Peak (E. Twin) is a fine-grained variety of the same rock. This peak, and the general average of the mountain range may be 500 feet higher than Ogishkie Muncie lake. The Twin Peaks are conspicuous because they stand isolated, further north than the rest of the high land, not because they are higher.

Fox lake, which is 141 feet higher than Saganaga, affords a fine exhibition along its south shore, of the broken condition of this quartzyte-slate-conglomerate formation. The bluff rises nearly perpendicular, but is somewhat rounded off by glaciation, and the edges of the bedding cross the face of it in a very tortuous and angular irregularity. Some of the beds which are nearly horizontal are terminated at one place by a perpendicular line, on the other side of which the beds are nearly vertical. In other places the bluff shows both synclinal and anticlinal bends.

Ash lake (or Agemok lake) is 200 feet above lake Saganaga. On the portage from Fox lake to Ash lake the formation strikes S. E. and N. W., with a dip S. W. of 60° to 80°, the most of the way. It then changes suddenly to a strike S. W. and N. E., and then soon becomes confused in a general breccia. Near Fox lake, where the beds strike S. E. and N. W., there is a ferruginous belt. Through about four feet the hard slates are rusty with hæmatite. The pieces are also feebly magnetic, but there is not enough iron to be of any value.

766. Iron ore near Fox Lake.

Gobbemichigomog lake is 210 feet above Saganaga. At its west end, just west of the town line is a northward facing hill of bedded trap, and a low range runs along the south side of the lake, but the main hill-range strikes along north of this lake, jogging a little to the north.

767. From the south side of Gobbemichigomog lake. A fine-grained heavy rock of a gray color, resembling the rock No. 677, evidently having much chrysolite.

There are several short perpendicular bluffs of bedded trap, some of it approaching the last in characters, along the south shore of Gobbemichigomog lake; and one of them is quite ferruginous. They rise from 20 to 40 feet. From one near the lake is obtained—

768. Somewhat irony trap, with chrysolite and mica.

Crooked lake is 217 feet above Saganaga, and Little Saganaga is 225 feet. About Crooked lake the country is wholly in the trap of the Mesabi. It rises in numerous knobs that make rounded, bare islands. The same rock continues to and into Little Saganaga lake where it also causes many islands. In some places it rots and crumbles easily as at Beaver Bay.

769. Trap, from the N. W. end of Little Saganaga.

770. On the south side of Little Saganaga the rock weathers white. It rises in higher bluffs, resembling the Rice Point gabbro, and even approaching the whiteness and nearly the purity of the so called "feldspar rock." It is mainly of feldspar but also contains magnetite and a little pyroxene. The hills and ridges show in general a course bedding which dips south. Ridges 10 to 50 feet high. The sample collected is weathered. Boulders of iron ore like that of Mayhew lake, are scattered about.

East-and-West lake is 231 feet above Saganaga.

771. Pinkish-red vein of syenite in rock No. 770, dipping E. 75°. It is 20 inches wide, on the south shore near the east end of East-and-West lake. This red syenite here is comparable to the red syenite asso-

ciated with the gabbro at Rice's Point. In both places it penetrates irregularly through the gabbro.

The lake in Frog Rock river is 241 feet above Saganaga. On the portage north from the lake in Frog Rock river are to be seen several veins of red syenite in the feldspar rock of the country, like 771 dipping E. The dip is generally south, about 50°, but is also S. E., E., S. W. and even N. W.

772. From a vein, one foot wide, of this rock in the neighborhood of the east-dipping red veins. This is coarsely crystalline, and consists of the usual minerals in the gabbro of Rice Point, but also here seems to have quartz and mica, perhaps derived from the red rock with which it is in close association. This whole formation resembles "Rice Point granite" in outward characters, and in mineral composition. It sometimes decays in round masses, as if at first a conglomerate, in the same manner as near the Duluth depot. (V. No. 4 A.) The last lake in Frog Rock river is 258 feet above Saganaga. Passing from this lake by a long portage toward the southwest, the Mesabi lake is reached, 338 feet above Saganaga lake.

773. Rock of the country, about the last lake in Frog-Rock river. It is a gabbro. This formation not only seems to be the "Rice Point granite," and the iron-bearing rock of Mawhew lake, but also to have furnished the feldspar masses of Castle Danger and Beaver Bay. The portage from the last lake in Frog-Rock river to Mesabi lake rises 150 feet, and passes nearly all the way over this rock. Merabi lake is 70 feet lower than the divide, and its outlet is toward the north, uniting with Frog-Rock river.

The same rock continues nearly across the portage to Duck lake, where another formation sets in, viz:

774. This comes in apparently *through* No. 773, at first, but afterward it lies on 773, and in rude lenticular and broken bedding dips to the south. It forms a range of hills about 100 to 150 feet high next west and south of Mesabi and Duck lakes. It has been molten, as evidently as 773, and in that sense it is an igneous rock, but it differs from it in its mineral composition. It is a reddish syenite, but seems to contain mica, as well as some plagioclase. In passing along Duck lake considerable confusion prevails in the relative positions of Nos. 773 and 774. Along the south side of the point that separates the lake into N. E. and S. W. parts, No. 774 plainly lies on parts of No. 773, but on the east side of the lake, there is considerable mixing, the two changing places suddenly, and either one being in patches in the other

—particularly 774, embracing masses of No. 773, and suddenly cutting No 773 like dyke-rock.

775. At the S. E. end of Duck lake 773 lies on 775, which is the well-known and so-called "red granite." This lies in even and regular beds of four to eight inches, (or in beds of three to four feet), dipping south, amounting in all to about twenty feet, the rock 773 being unconformable on it, but intimately cemented to it, as at Rice Point. Over both of these, further toward the S. E. No. 774, comes in again. (V. 776.)

Duck lake is 345 feet above Saganaga.

L. lake is 413 feet above Saganaga.

The portage is along the stream between these two lakes and is over the rock—

776, which is seamed and blotched with the red rock 775 and appears to be affected by it throughout. This rock prevails through this portage with occasionally a characteristic patch of No. 773—as seen at the south end of the portage. At the point where the portage leaves L lake is a bluff at the left made up of the following (777-780.)

777. A characteristic gabbro, seamed by red syenite, and weathering nearly white, porphyritcally, so as to appear much like No. 773. This passes downward into—

778, which was obtained about thirty-five feet below the top of No. 777 and near the next. This is apparently a form of the gabbro when in closer contiguity with the sedimentaries and has been penetrated by minerals from them. It is finer-grained than No. 777 and darker, but also seems to have orthoclase and mica. These together, make a thickness of about forty-five feet, from the top of the bluff downward. They are one in structure, dip and general characters. They dip south in heavy layers at an angle of about thirty degrees.

779. Red syenite, unconformable under 778, showing about fifteen feet. What appears like bedding in No. 779 may be coarse jointage, as there are two sets of planes, one set being perpendicular to the bedding of the gabbro overlying, and the other crossing it so as to have a dip south of about seventy degrees.

780 is a form of the rock in the same bluff about twenty feet below the top—evidently a part of the igneous rock, but affected by proximity to the underlying rock so as to appear like a dioryte.

There is a striking contrast in the appearance, form and color of the rocks 777 and 779.

Wind lake is 473 feet above Saganaga lake. On the portage to Wind lake the rock No. 777 is the prevailing rock at first, but is varied by patches of red rock, and a fine-grained rock like No. 778. Then—

781 prevails, cut by seams of red rock like the last, and having sudden variations to Nos. 777 and 778 and even to No. 774. This is a light-colored, fine, syenitic granite. The red rock continues to increase in area till at Wind lake, nearly one-half of the visible area is of red syenite, the rest being some of the rocks 777 or 781. The most of the surface is bare rock and can be examined easily. The red syenite is in the lower parts and the other rocks are in the higher. It always appears to come out *under* the others when it appears in bulk and indicates its proper relation to them. The red seams which pass upward into the dark rocks are exactly simulated by the same relations of the gabbro and the red syenite at Duluth, and this place must be at about the same geological horizon. There is much reason to regard the rocks 773, 774, 776, 777, 778, 780, as all phases of the same great formation, an igneous rock which flowed over 775 and 779, and in contact with them was modified into the various textures and degrees of fineness that they illustrate; and that the red rock, which must be regarded as the red formation of the Brulé and the Great Palisades, in the process was fused and injected into them. This red formation, which makes red syenites and gneisses, belongs in the lower portion of the cupriferous, as hitherto classified, and seems to be the same that in Michigan has been grouped by T. B. Brooks in the Huronian.*

Along the north side of Wind lake, these formations, the red and the gray, are somewhat interbedded, and so brecciated and mixed that the bluffs are spotted promiscuously with the two colors. Sometimes, also, they seem to have been fused and blended into a rock that is neither red nor gray.

782. A micaceous quartzyte, of a light red color, from the S. E. side of Wind lake. This is less granitoid than usual, but is still a part of the red rock formation.

783. A micaceous brown quartzyte, of the same series of rocks, from the S. E. side of Wind lake. This is one of the metamorphosed sandstones of the cupriferous.

At the place where the portage trail leaves Wind lake is a bluff which in form is a duplicate of the red quartzyte bluffs at New Ulm, and in Rock and Pipestone counties.

784. Is from this bluff, and constitutes the most of it. It is a hard, red, fine, sub-granitzed quartzyte, somewhat sprinkled with darker specks, that may be chloritic or micaceous, or graphite, and having

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*Am. Jour. Sci. (3), XI. p. 206.

rarely a distinct crystalline grain of orthoclase. It is in distinct sedimentary layers that dip S. at an angle of 20° to 25°.

785. In irregular patches and areas, on the face of the bare bluff, rounded off by glaciation, may be seen this rock, which is a true igneous rock, nearly black, fine-grained, a trap-rock, a form of the gabbro such as is seen along the Lake Superior shore where the molten material was rapidly cooled in contact with the sedimentaries. This is a phase of the igneons rock of the country. This bluff throws light on the geology of the southwestern part of the State. If this gabbro belongs to the cupriferous, and these red gneisses also, then may not, not only the red quartzytes (Sioux quartzyte of Dr. White, and the Baraboo quartzyte of Wisconsin), but also the contiguous red gneisses and granites of the Upper Minnesota Valley? In other words may not the red gneisses and granites of the Upper Minnesota Valley be in the extension of the great modified cupriferous, where instead of an actual molten outflow, or series of outflows, the disturbing agencies operated to produce a widespread and complete metamorphism in the contemporary strata? Those granites and syenites differ widely from the granites of Saganaga—the only ones known to lie below the great conglomerate of Ogishke Muncie. Though the rock of this bluff is not a pure red quartzyte, in other places this red rock is a pure quartzyte which can hardly be distinguished from the quartzyte of New Ulm. At the same time there are portions of the southern red quartzyte that are as much granitized as the rock of this bluff. This is particularly true of the outcrops at Baraboo, Wis.

Spotted Rock lake is 520 feet above Saganaga. This lake is so named because of the mixture of red and gray rock as described at the south end of Wind lake. Here it is all about the shores, the red gradually increasing in area, and rising into hills.

At Little Saganaga lake were a few green trees of Jack pine (Pinus Banksiana) about three or four inches in diameter, but south of that lake the country has been twice burnt over, as at Ogishke Muncie lake, so that it is almost bare of vegetation. The first burning destroyed the large trees, and the second, in burning the fallen forest, killed the new growth, which was then one to two inches in diameter. About Little Saganaga this young growth escaped the second fire; but in nearly all parts of this traverse the country north from Young Sawbill lake affords unrivalled opportunity for unraveling the geology of this much-studied but little-known horizon of the earth's crust.

Leaving Spotted Rock lake the canoe route passes over a long rough portage trail, crossing the hill range known as the ***Mesabi Range.***

This range seems to be the westward extension of that in which is Brulé Mt., while that "Mesabi" which passes near Gobbemichigomog lake has been distinguished sometimes as the Giant's Range. Sawteeth Range is near the Lake Superior shore. The Mesabi range rises where the trail passes it, 676 feet above Lake Saganaga, or 1,592 feet above Lake Superior. The dark rock which is mixed with the red granite formation continues to the top of the Mesabi, having its usual changes of texture, and a few spots of red rock. But before reaching the summit the texture becomes what is shown by—

786 without much variation. This is from near the top of the range. This is rather fine, heavy and chrysolitic. After passing the summit the formation is occasionally coarser, and even takes the characters of No. 773 in small patches and veins.

787. Its prevailing features on the south slope are shown by this number, which is like other samples from the same formation elsewhere, a rather fine chrysolitic gabbro, which continues to South-side lake. From the top of the Mesabi range can be seen both the Giants range of hills and the Sawteeth mountains.

South-side lake is a tributary of Temperance river.

From South-side lake the course pursues a slow-running river to Sawbill lake, with ridges of rock No. 787 on either side rising about fifty feet, or less, occasionally with a little show of the red rock, but generally free from it. From Sawbill lake the canoe enters a swamp through which the same river flows, to a rapids, where, after a short portage, a lake is reached in the same stream, the same rock continuing. This is known as Young Sawbill lake, and by our aneroid is found to be 454 feet above Saganaga lake. At the rapids the same rock appears, but about Young Sawbill lake the country is drift-covered, and about the S. W. end of this lake the native forest is green, having escaped the fires. This, however, does not continue far, for at the south side of Rat lake the forest is fire-killed. No rock is seen on the portage from Young Sawbill to Rat lake, but where the trail leaves Rat lake for Burntwood lake the same rock as the last appears.

Rat lake is 459 feet above Saganaga, and Burntwood lake is 439. These are both tributary to Temperance river.

On the portage from Rat lake the formation is mixed with the red syenite. It shows the characters of the Rice Point gabbro, and irony patches like dykes, having much magnetite.

On the east side of Burntwood lake the same rock can be seen in place, but the prevalence of drift and the greater amount of vegetation, makes the examination of the geology of the country more difficult, and the idea one can obtain is more general than in the country north of the Mesabi range.

The portage to Temperance river passes over a range of low hills made up of rock like much of that already mentioned, belonging to the same formation, but somewhat darker colored, with magnetite and hornblende, approaching dioryte.

788. Dioryte from the E. side of Burntwood lake, the rock of the country.

789. From the portage trail to Temperance river lake, but rather darker than the average—a dioryte with much hornblende and considerable magnetite.

Temperance river lake is 417 feet above Lake Saganaga. This lake, which is nothing more than an expansion of the river is terminated by rapids which have a descent of eight feet. On the portage round these rapids almost the only rock seen as boulders are of the red syenite series. A lower rapid in Temperance river has a descent of thirty feet. Temperance river is rather a succession of lakes, or lake-like expansions. The portage round the last rapids crosses red syenite all the way, seen occasionally in place. The forest is killed by fire over the east half of the portage. At the foot of these rapids is another lake-like enlargement of the river, after which the route ascends by portage, a tributary of Temperance river, and reaches a lake in this tributary, which is found to be 419 feet above Saganaga lake. This last portage passes at first along the foot of and then ascends and continues on a ridge of morainic drift, consisting so largely of red granite masses (from one to six feet) that one could travel the whole three-fourths mile without stepping off them. There is also in the mass occasionally a boulder of dioryte like No. 788 or 789. When burnt the whole country appears red, from the prevalence of this red drift. The next portage leads to a lake in Poplar river, and the lake is given an elevation over Saganaga lake of 449 feet by connected aneroid readings. Through this portage the red morainic drift continues, and along the lake also. Near the lake appears—

790, in one of the ridges over which the trail passes. It seems to make up a large part of the ridge. It is a very fine-grained, gray, metamorphic (?) rock, or fine basalt.

Along the west shore of Poplar river lake are two exposures of the rock No. 790, and from the fact that in one place a lot of red granite is embraced in it, it is judged to be an igneous rock.

791. From one of these exposures, which is almost exactly the same as 790.

Although there is abundance of drift along Poplar river, the red boulders are almost entirely wanting.

Square lake is 444 feet above Saganaga.

Small lake is 437 feet above Saganaga.

There is still a considerable sprinkling of red syenite in the drift along these lakes. New varieties of rock also appear, such as the trap rocks of lake Superior, and amygdaloid. The forest, fire-killed generally since leaving Temperance river, is still standing. Camp lake is 425 feet above Saganaga.

Smoke lake is 411 feet above Saganaga.

Sunrise lake is 399 feet above Saganaga.

Rice lake is 394 feet above Saganaga.

Big Lake is 304 feet above Saganaga.

There are rapids between all these lakes. The long portage from Rice lake S. E. is wholly over drift, no rock in place being visible. The same is true of the three portages last before. The country is rolling and shows many boulders. The stream leaving Big lake is three times the size of that leaving Rice lake.

Sucker lake is 274 feet above Saganaga.

Poplar river, where the portage from Sucker lake strikes it, is 16 feet above Saganaga. The portage between Big lake and Sucker lake is wholly over drift, showing no rock. That also to Poplar river is over a smooth surface of drift, without once showing rock in place. After a descent by river of about five feet, rapids occur which have a further descent of 40 feet, bringing the river here to the level of 29 feet below lake Saganaga. After a further descent of three feet by river the last portage begins, leading to lake Superior, which is found by the series of observations to be 737 feet below Saganaga, or 179 feet less than the series of aneroids of 1878, from Grand Portage.

The Sawteeth Mountains through which the Poplar river passes in a narrow deep gorge, rise above the trail which runs near their base 563 feet, and 1111 feet above lake Superior.

These mountains seem to be made up, here, of the trap-rock of the shore series, but become coarsely crystalline, or porphyritic, gradually, toward the top, as shown by samples obtained at different elevations, viz:

792. From the foot of a hill facing north precipitously. N. E. ¼, Sec. 20, T. 60, 3 W. on Poplar river. This is a high, trap hill, like others in the vicinity.

793. From the foot of the last hill (or nearest Lake Superior), west

side of Poplar river, 600 feet above the lake, similar to the last. A chrysolitic trap.

794. From the same hill one fourth way up. The same rock, with an occasional crystal of twinned feldspar porphyritically displayed.

795. From the same one half way up. The same rock with coarser feldspar crystals.

796 From the top of the hill, 1111 feet above lake Superior. This is the same rock, with more abundant coarse feldspar crystals, the matrix, which constitutes about one half of the mass, being undistinguishable from the rocks 793 and 794.

There may be beds of amygdaloid in this hill, but none were seen. On the very top of the hill is red clay drift, and boulders, and the last portage trail is over a nice plain of red stony clay, gradually descending to Lake Superior—the lower half of it being suitable for farming. The actual connection of this hill with the rock of the shore is not visible along the trail on account of this drift. The only opportunity for tracing it out there would be in the difficult, if not impracticable, ascent of the river gorge itself.

Rocks from various parts of the State.

797. The trap of Taylors Falls, (V. 820.)

798. Porphyritic trap, of Taylors Falls.

The number 797 contains nothing that prevents it being classed as an igneous rock, and it may be of the cupriferous, but the latter (798) has hornblende and orthoclase, as well as epidote, and has the aspect of a metamorphic rock.

799. Light-colored syenitic granite. Saganaga lake: The first island on entering the lake from the east; same as No. 316.

800. Syenitic granite, from the falls of Gunflint river, at the first portage going north from Gunflint lake; the same as No. 315.

801. Gray, micaceous syenite. From S. E. ¼, Sec. 17, T. 35, R. 30, about two and one half miles S. E. of St. Cloud, on the east side of the Mississippi river. A large, rounded knoll of this syenite was opened in 1881 by Saulpaugh & Company for use in the piers of the R. R. bridge over the Missouri at Bismark. It is a rather coarse rock, consisting mainly of quartz, orthoclase, hornblende and black mica. The orthoclase is only in part flesh colored, the rest is nearly white. This knoll covers 25 or 30 acres and rises about 20 feet above the general surface, the longest diameter being E. and W. (a little N. of W.) but oblong. A dyke four feet wide cuts it N. E. and S. W. consisting of heavy trap rock, very fine grained, viz:

802. Trap dyke cutting No. 801 in direction S. W. and N. E.; 4 feet wide. This rock, being much jointed, would facilitate the quarrying of No. 802, had the quarry been started along side of it.

803. Red quartzose syenite from an old quarry of Breen & Young, E. St. Cloud. In general the "red granite" at E. St. Cloud is but a small part of the whole of the rock.

Between the quarry of Breen & Young and that lately opened by Saulpaugh & Co , is a ridge of high land running E. and W. (nearly), which seems to consist of drift materials.

804. Gneiss, from Granite City. (Garrison.)

805. Light colored syenite, Watab, like No. 801, but rather finer in grain.

806. Light, red syenite, Watab.

These last two numbers represent the stone going into the piers of the Bismark R. R. bridge, quarried here also by Saulpaugh & Company. The gray is changed to the red in an interval of about six inches. The north portion of the quarry is red, and the rest is gray. These two numbers seem to duplicate numbers 801 and 803. This range of syenite runs N. and S. at least two miles, and some of the knolls rise 10 to 20 feet. East of this quarry are said to be similar knolls, some of them rising 25 or 30 feet. (V. No. 835.)

At Duluth the rock No. 43, which outcrops near the railroad in the street in front of the Engine House, where it has been quarried lately for use in the basement of the new School-House, and extends N. E. to the falls of Kinichigaquag creek, makes an important member of the rock series visible on the hill-slope at that point. Much of it is bare north-east of the Engine House, within the limits of the city, showing, on weathering, a finely and indistinctly porphyritic structure, but in the main it is a massively bedded, homogeneous, dark rock, with numerous joints, the surface being frequently glaciated.

807. Passing toward the N. W. from the line of strike of No. 43, and thus onto rocks underlying No. 43, at the distance of about one-fourth mile, (but also somewhat to the westward) a rough, blotched rock is found spreading over a considerable area, running in the same general direction as No. 43. This, in general color, is like the last, but it is much finer in grain, and owing to its rough and blotched exterior under the weather, it must have been a conglomerate at first. Were it not for this blotched exterior, which shows a variation in composition, it would be placed at first in the general class of fine basalt, or diabase—like some of the narrow dykes, or like the rock adjacent to a dyke where the heat has baked it and allowed it to cool rapidly, leav-

ing it nearly black and very fine-grained. This conglomerate, while closely connected with the gabbro range, is unlike anything seen in the Cupriferous, and recalls the great conglomerates of Ogishke Muncie lake, although no tendency to slatiness can be seen anywhere. It has occasional light quartzose nodules, somewhat micaceous, but the most of the pebbles are of the color of the rock, except on weathering. In other places, by reason of the weathering, and the fires that have prevailed, a red banding is seen rudely conformable with the supposed bedding, which, on being broken reveals a texture and fracture as well as color and hardness, of the quartzytes of Pigeon Point. This No. (807) illustrates this gray quartzyte, but not the general character of the conglomerate.

808. Underlying this supposed conglomerate is the red syenite, or at least a red quartzless rock, (which is sometimes brown rather than red) which is associated intimately with the gabbro at Duluth. This red rock is to be seen in irregular patches in the gabbro on the hillside; and by carefully following it downward, it is seen to outcrop along the bottom of the creek in such proximity to the conglomerate, with a dip S. E. as to throw it under the conglomerate, unless there be in some way unusual irregularity in the trend and extent of these beds. The red rock is visible under the bridge, and above it in the creek, on the diagonal road going N. toward the Weller Farm, yet within the limits of Duluth. (V. Nos. 42 and 43.)

By following the strike of the red rock westwardly the following facts can be ascertained by anyone:

1. It falls away, except on the higher slopes, or breaks away so as to disappear, for the distance of about half a mile, though a lower strike appears near Superior street. (No. 42.)

2. This interval is followed by a rock showing orthoclase in the gabbro, as well as quartz, as in the rock at the Depot, (No. 5); and in the lower slopes N. E. of the the Rice Point quarry, this character is abundant. This seems to be explicable on the hypothesis that the gabbro flowed over, fused and mingled intimately with the red rock. But it may be of a lower rock horizon, referable to the horizon of the diorytes and their associates in the rocks of the northeast angle of the State. (V. Nos. 671 and 709.)

3. This "red rock" which is in much of its area, quartzless, becomes the red syenite that has been described as mingled with the gabbro, then showing quartz.* This is probably due to the complete

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*See *Proceedings of the American Association for the Advancement of Science*, 1881, Cincinnat Meeting.

fusion of the original sedimentary beds, allowing the otherwise invisible quartz, disseminated cryptomerously, to become aggregated in crystalline grains. At points more distant from the gabbro the only crystals to be seen consist of orthoclase, or of orthoclase and changed hornblende. The number 808 represents the complete crystallization of the elements, and is from Newson's old quarry, at Duluth, while Nos. 7 and 42 are from the same without the crystallization of the quartz.

Owing to the great general resemblance of the conglomerate (above) in its matrix at least, to the rock No. 43, which is seen in front of the Engine House at Duluth, and which overlies the conglomerate there is reason to suppose that they belong together, and that hence they are both of the metamorphic series. If the red rock be of the cupriferous, these must be, since the former runs below the latter. The question then arises, why is this dark-blue or black, and the red rock red. This cannot be due to greater heating and baking, which sometimes has been the cause of black rocks, locally, as described on the Lake Superior shore, in No. 52, and at other points, since under such circumstances the red rock remains red. Hence this seems to be due to difference of original constitution, making it resemble the rocks of the Animikie Group.

809. At Boyle's quarry, on the railroad above Fond du Lac, is a layer of red shale, lying in the heavy sandrock, which is much like the pipestone from Pipestone county. Its greatest thickness is sixteen inches, and it extends at least thirty feet, when it disappears under the drift clay.

At the quarry on Mission Creek, a short distance above Fond du Lac, in the *light-colored parts* of the sandrock are streaks and shades of red or brown, both in those parts having oblique sedimentation, and in those having horizontal. In some cases these dark streaks embrace lenticular pieces of shale, in which case the central parts of the pieces embraced are red or brown, and the outer crust is green. In some pieces the whole is green, or has a very faint central shade of red. On the contrary *in the brown parts* such red or brown lumps of shale are wholly brown, and have no crust of green. This seems to show that the original color of the shale lumps was red or brown, and that by some chemical reaction those in the lighter beds of the formation have become wholly or partly green. Thus, green specks and sometimes large green spots, at least green lumps of shale, are disseminated through the lighter beds, and red lumps through the dark brown beds.

810. Coarsely crystalline "feldspar rock" from two and a half or

three miles below Beaver Bay, showing coarse lamination, and evident striation. (V. No. 814.)

811. "Red granite," massive, from the large red granite island three or four miles below Beaver Bay which is arched on the lakeward side.

812. The "palisade rock," two miles west of the Palisades, S. E. ¼ Sec. 32, T. 56, 7 W., resembles the gray slaty rock at the mouth of Beaver Creek. In some places the Palisade rock here has the appearance of being crumpled, and also of having been originally in some places a conglomerate. Another bluff of light-colored Palisade rock occurs about one and one-half miles west of the Great Palisades. The trap rock which occupies the coast between here and the Great Palisades, runs under this Palisade rock toward the west. It shows a broken and zigzag line of junction with the palisade rock, parts of each penetrating the other, as if each were nearly molten. A little further west it also embraces masses (say ten feet) of the palisade rock, hardened and blackened by quick cooling, showing its sedimentary (or other) closely jointed structure in marked contrast with the massive or heavily bedded, non-conforming layers of the trap. (V. No. 52.)

The west end of the Palisades rises over the greenish and reddish (and then amygdaloidal or red porphyritic) trap, very plainly.

813. (V. 140) The lowest visible part of the rock at the Great Palisades, is confused and crumpled, in the same manner as where this rock is in contact with trap a short distance further west, as noted above. Yet it is very difficult to see the underlying trap, on account of the continuous heavy talus. This number represents *the red* banded felsite from the bottom of the Great Palisades.

There is apparently a continuous belt of this rock underlying the Palisades, outcropping in a narrow belt near the water. It is mingled in various ways with a crumpling of banded rock like that of the bulk of the Palisades (139), and with crumpled bands of light color, some of which stand verticle, or are curved obliquely, some of the latter showing a porous or even a spongy condition due to the solution and removal of some of the minerals. There is also a hard, dark, brittle, fine felsite, though porphyritic like the rest, but occurring in nodules and concentrically banded masses which endure more effectually the weather. They seem a more hard-heated and burnt condition of the Palisade rock. Indeed great confusion exists at the bottom of the Palisades, due perhaps to the forcible injection (as laccolites) of igneous rock below, breaking, crumpling, baking, fusing and metamorphosing rapidly the adjacent beds.*

814. There is one place two and one half or three miles east of Beaver Bay, where the "Feldspar rock" is bedded, and dips easterly, in all respects like the usual trap of the shore. It here shows also a confused mixture with the trap, in which in other places it seems to be (and is) embraced as isolated masses, as at Splitrock Point. This bedded condition is very evident in coming from the N. E. as the conspicuous surface slopes in that direction. Narrow dykes of fine-grained, gray doleryte cut the feldspar rock. One dyke is six inches wide, and one is about nine. They are about parallel, 25 feet apart and run E. and W. by compass. The feldspar here is very coarsely crystalline and is represented by No. 810. The alternate beds consists of bands of coarse crystals, succeeded by layers of fine crystals in which are also numerous grains of a more rapidly disintegrating mineral which by becoming disseminated stains the whole of a green color. This disintegrating mineral seems to take the place of the augite seen in the gabbro, therefore, the bedding is an alternation of gray, coarse feldspar, with green, decaying gabbro. No. 814 represents the feldspar stained *with the green-weathering mineral.* The bands of color are from three to six inches, fading into the uncolored, clear, feldspar, above and below. About 20 feet of this bedded feldspar can be seen here. (V. 694.)

815. From the same place as 814, represents the gabbro of more massive character with which the feldspar (810 and 814) is confusedly mixed, but between which there is not seen here any gradual transitions.

From the Palisades, (and Baptism river) to Splitrock, is one great igneous bed, which by appearing and disappearing at the waterline, seems to have been the principal agent in bringing out the geology and causing topography. It lies under the rock of the Palisades, and under the red islands &c., as at Beaver Bay, and over the feldspar knobs, from both of which it has derived fragments. The metamorphosed red shales above, making the red series of crystalline and semi-crystalline rocks of the shore, were apparently brought into that condition by the agency of this igneous rock, but the relation of this igneous rock to the "feldspar rock" is not so easily ascertained. It is certain that the gabbro of Rice's Point is only the usual condition of the feldspar rock,

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*The immediate proximity of igneous rock, along the coast usually, does not show the most perfectly changed and crystalline condition of the sedimentaries, nor *vice versa*; but when large bodies of either are involved the crystals are best formed The immediate contact is a place of crypto-crystalline rock, both rocks tending to suddenly become alike, and generally almost or quite black.

and hence that the gabbro range of which Rice Point is the western termination, lies below many feet of red, metamorphic sedimentary beds that apparently belong to the Cupriferous.

816. (V. 532 and 551.) Pieces of rock like the "Rice Point granite," embraced with evident feldspar boulders also, in the trap at Beaver Bay, sometimes in large blocks. This seems to be the same rock as the "feldspar rock" or a variation from it. Indeed there are here also masses of coarsely crystalline, green, trap-rock embraced as isolated blocks, in the finer green trap. *The gabbro, and the "feldspar rock" all pre-existed, and bore the same relation to an outflow of later igneous rock.* This point shows a wonderfully confused and brecciated condition prior to the final cementation.

The red rock appears, at Beaver Bay, as pebbles and boulders in the dark trap, and as strings and veins. It is in contact with masses of feldspar, crowded between it and trap. The spots and masses of red rock are distributed, in some cases with pieces of the feldspar rock, throughout the trap, showing the accession of both ingredients when the trap was molten, and even contemporaneously. The "feldspar rock" is derived from previously hardened outflows, and the red rock from the sedimentaries at the *locus* of the outflow. It is true that a long interval of time may have elapsed between the former and the later outflows; or indeed that the "feldspar rock" is of an entirely different formation earlier. Any older formation might furnish loose masses to an outflow of trap.

The interesting facts about Beaver Bay may be summarized thus:

1st. The feldspar masses are blocks detached from their parent rock.

2nd. The trap in which they are embraced is in some places much affected by the infusion of minerals from the sedimentaries, and then shows a reddish color, but it is generally of a greenish or greenish black color.

3rd. Besides this effect on the trap, as seen near the mouth of the creek on the north side, there are included masses of red syenite, and of the ashen-brown, or purple, rock seen near the mouth of the creek. (Nos. 127 and 528.)

4th. These red masses are sometimes in contact with and firmly cemented as by fusion to the feldspar surfaces, and also show a basaltified jointage.

5th. The red syenite here can hardly be called syenite in all cases, but is instead a nearly black (at least a dark purplish) fine-grained rock which in outward characters resembles the Two Harbor rock, but at the same time shows translucent, angular grains like the Palisade rock. This fine-grained condition is seen when it is near the rotting green trap.

6th. The red syenite here was apparently at first a red conglomerate, showing the irregularities of color, hardness and minerals that such a metamorphism produces.

7th. There is within a few inches a passage from the red crystalline characters of the bluff on the south side of the creek to those of the above fine-grained black rock, the rock being one continuous mass.

8th. The red rock is not only a metamorphosed conglomerate, but it was brecciated and then mingled with the trap so that angular pieces appear in the trap when worn off by glaciation.

9th. The red rock was fluidized. It runs about in belts and veins, not only between the trap and the "feldspar rock", and through the trap, but also through the "feldspar rock."

10th. The feldspar rock here passes into gabbro, or at least into a rock like the Rice Point rock, and then it is more generally mixed with the red rock.

11th. On close examination it appears that even as "feldspar rock" it must have been as completely molten as the red rock itself.

12th. This red rock also appears as the palisade rock, rising in a knob near the creek, on the north side, with the lithologic characters and jointage, and translucent grains of that rock.

13th. Under this knob lies a rotting green trap, visible on the north side. A little further east, but within the bay, this green trap, although basaltified, is beautifully mottled and striped with the red rock.

14th. Still further east, on the north shore of the bay, the green trap holds both red masses of the sedimentaries and white masses of the feldspar rock, the latter being, however, more nearly like the Rice Point rock, at least in some large masses—yet much of it is unmixed and clean feldspar.

The above observations, carefully made at Beaver Bay, seem to decide certain points that before were largely hypothetical, or were based on generalizations from a grand review of the geology of the "north shore," and not on special and minute study of the notes made or of the specimens collected.

(1.) The Great Palisades are of a rock, the equivalent, geologically, of the slaty quartzyte (Nos. 127 and 528) at Beaver Bay and below that point; and to the red syenite of the islands below Beaver Bay, and of the west bluff of Beaver Bay; and to the red (often quartzless) rock associated with the gabbro at Duluth. These beds also constitute the red bluffs at Tischer's and New London, as well as the red rocks at Baptism river, and the eastern palisades. In a number of instances the bottom of this great red (metamorphosed) shale has been found to be a conglomerate.

(2.) The feldspar masses are of the same rock (geologically) as the Rice Point gabbro, and both are the result of copious, and perhaps one of the earliest, igneous outflows of the Cupriferous. The more copious the igneous outflow, the coarser the resulting crystalization and the higher the hills formed, as well as the purer the labradorite material. The later outflows derived fragments from the "clinker fields" and from the knobs of feldspar already formed, as they passed along; and when these had been covered by later sedimentation such sedimentary beds were also involved in the later upheavals and fusions. (V. No. 817.)

(3.) It seems as if an igneous outflow,—perhaps the great labradorite—was thrust laterally under the sedimentary beds that went to form the palisades, heaving up those beds, and sometimes fusing them, and mingling with them, as seen near New London and at Beaver Bay, though no such evidence can be cited to show the laccolite formation in later strata. (V. No. 521.)

It must be admitted that it is not at all certain that the labradorite outflow was the earliest, so far as the observations go. It is simply the most conspicuous, and seems to lie nearest the Huronian. Besides this it is still a question whether the green basaltic traps, as at the east side of Beaver Bay, and as that coming out from under the Great Palisades, or the melaphyr-like traps as at Petit and Grand Marais, can be shown to pass into the gabbro without the intervention of any change but difference of proximity to the center of outflow. It is probable that such a gradation can be shown, the rock at Knife River Point being an intermediate step, and that at Encampment Island another.

To illustrate the steps in the change from the feldspar rock to the gabbro, reference may also be made to several large masses lying in the water near the red bluff at the west point of Beaver Bay on the east side of the bluff.

817. Hardened shale, from a brecciated, semi-metamorphosed reddish conglomerate at Two Harbor Bay, lying immediately over the Two Harbor rock, and immediately under heavy green doleryte containing masses of feldspar, (V. No. 525.) This shale is charged with laumontite. Certain blotches are charged with it, particularly in the

form of amygdaloid, the cavities being about one-fourth inch, and less, in diameter. The blotches, or spots, make up sometimes the most of the rock. They are without any order of arrangement. Intercallated amongst them are laminated patches and seams of red material which is fine-grained, and was probably a shale at first, disseminated amongst a coarse conglomerate in the same manner as shale is often seen disseminated throughout a conglomerate, (as at Manitou river); the laminae being parallel with the general dip. Of this conglomerate breccia thirty-five feet are to be seen.

The bottom of the overlying trap is a perfect pudding-stone of pieces of gabbro and feldspar masses. The largest mass of "feldspar rock" at the point east of Two Harbor Bay shows a bedded, at least a banded, structure running nearly perpendicular from top to bottom, similar to that described east of Beaver Bay (No. 814.) It is crossed obliquely by an old dyke, which dyke is faulted, about midway of the bluff, about two feet. A small dyke also runs near the water about horizontal, derived from the trap at the left which, near the water, seems to run below the feldspar. This lower part of the trap holds a piece of the red syenite, near the water level.

As to the "Two Harbor rock," its character and origin are still to be determined by more minute examination of the samples collected, and by further field observations. It has been referred to as a metamorphic rock, in some of these notes, but it has also very much the aspect of a fine-grained, igneous rock. It has the jointage, as well as the general homogeneity of trap, and the red bands crossing it, and the geodic spots seen on its surface, perhaps, have originated from the overlying sedimentary conglomerate. It does not have the appearance of being, exactly, the equivalent of the quartzless red rock at Duluth, but it must occupy very nearly the same stratigraphic position.

818. On the east side of Splitrock Point is a grand pudding-stone of feldspar, gabbro and dark-trap masses cemented still by a dark trap. The most of the so-called feldspar here is really gabbro, very much like the Rice Point rock. This number is from such gabbro-like pieces.

East of this point, but within the same bay, are feldspar masses that show the green banding or bedding. The bands run nearly perpendicular. The lighter-colored bands are much more coarsely crystalline than the darker, which is also true at the point two and a half or three miles east of Beaver Bay, (814.) This is also cut by dykes and generally mingled with the matrix of dark trap in great confusion.

819. From the top of the high hill back of Silver Creek—the high-

est hill near the mouth of the creek, yet on the west side, rising 415 feet above the lake, though at a mile further back it rises perhaps 150 feet higher.

At Flood Bay (next east of Burlington Bay) are frequent slabs of laumontitic sedimentary shale strewn on the beach on the east side. They are at the same time sandy, of a brick red color, with spots of lighter red, and of green, like the Fond du Lac sandstones The amygdules consist of calcite and laumontite, but principally the former. Some of these slabs have distinct markings of fucoidal stems, some of them being large and long. As these slabs are evidently from the formation that forms the shore line generally, though where they are found no rock bluff is exposed, they unmistakably prove the sedimentary origin of the red laumontitic amygdaloids so common on the north shore, in another line of evidence.

820. Trap rock, at the railroad cut, Taylor's Falls. This is crystalline, tough, greenish with that internal structure that Prof. Pumpelly assigns to melaphyr, i. e. there are almost imperceptible forms of crystals that permeate the rock, and are so completely filled with the other constituents of the rock that they do not appear distinctly till the rock is weathered. They are generally about one-third or one-fourth inch in diameter, but they do not show any angles, and they do not have the color of pyroxene. When they are distinctly brought out they are seen as spots that completely speck the face of the bluff. They disintegrate more rapidly than the rest of the rock, sometimes assuming a green chloritic character that causes them to make little pits as large as a pea all over the surface, due to the more rapid removal of this green mineral; and sometimes they become gray gradually, giving the appearance of nodules of siderite disseminated through the whole.

821. Shows the green-weathered spots of the rock No. 820. The change to the geen mineral takes place at depths of ten to twenty feet below the surface, in the railroad cut.

822. Shows the gray-weathered spots of the rock 820. This takes place nearer the natural surface of the ground, and at the surface.

In No. 820 are seen sometimes small pebble-like lumps of red jasper, and larger deposits of chalcedony, the latter sometimes being elongated lenticularly, some like gash veins, four or five inches. The chalcedony also appears as pebble-like masses and as filling to scattered cavities somewhat in the manner of amygdaloid. Coating the joints, which are often slickensided, is frequently a green slippery mineral like delessite. Sometimes the chalcedony is more pure quartz, and is mingled sparsely with calcite. These characters are those of an igneous rock, and at the same time this rock differs quite distinctly from the gabbro at Duluth. The jasper and chalcedony recall the disseminated red jasper and quartz pebbles of the conglomerate at Ogishke Muncie lake

823. Pebbles from the conglomerate forming the lower part of the bluff excavated by the railroad where it crosses the highway south of Taylor's Falls. The bluff here is red-spotted and composed of a curious, coarse, conglomerate. It is dark-colored generally, looking some like the trap formation about Taylor's Falls, but the jointage and the texture are different Some of the surfaces are variegated with coatings of green, radiated malachite, and some are stained green without showing evidently the mineral producing the color. Some also are nearly black and some jasper-red. It is in some spots coarsely vesicular, or like pumice, or like amygdaloid. The amygdules received quartz at first, (as shown by the perfect terminations of crystals) and subsequently calcite and chlorite. Some of it is hæmatitic, and has a streak of red. It was here evidently a shale-conglomerate, but it has the appearance of having been heated and hardened, as well as mixed perhaps with igneous matter. In some places it is fine and crumbles like a dry shale. In some places its conglomeritic composition appears on weathering, the little rounded pebbles (of hardened shale, or of fine argillaceous quartzyte), rolling out entire. The pebbles have a great resemblance to the rock itself, but there are none of quartz. They are somewhat changed by decay.

824. The upper portion of this bluff consists also of a curious conglomerate, the matrix of which is represented by this number. It is a completely crystalline dolomite (apparently, though not yet analyzed) which effervesces in acid when powdered, and which contains fossils of *Lingulæ* &c., and nodules of course calcite crystals. Every grain is a perfect crystal; but in the upper part of the bluff this matrix becomes free from pebbles, and forms beds of dolomite like that seen in numerous other places along the St. Croix valley.

825. The great bulk of this upper portion is made up of boulders contained in No. 824, of which 825 is a sample. They have been said to have come from the "trap" of the region, and perhaps they do, but they are not like the rock 820. They are sub-angular and somewhat rotted. They are porphyries, of a green color, (now) or are homogeneous, resembling some of the rock seen in the Huronian. It is in these boulders that the green coatings of malachite are seen.

This conglomerate, which has its lower portions quite different from the upper, can hardly be separated into two by any distinct line of superposition. The matrix of the upper portion runs below parts that resemble, and indeed are the same as the conglomerate of the lower, while some masses above, embraced in this matrix, seem to be like the underlying conglomerate, and crumble in the same way. The lower characters occupy a thickness, visibly, of six feet, at the highway crossing, though in ascending the hill toward the north, it probably increases, while the upper characters have a thickness of probably 75 feet, rising to the top of the hill further north. Yet this interval is not all visible.

826. At the top of the hill north from the last, in front of Mr. Folsom's house, the rock 820 shows an alternate banding that resembles stratification, and would ordinarily be taken for that. This is seen over the surface of one or two square rods. The rock in general here is smoothed off by glaciation, and this character comes out distinctly on the planed surface. It is less coarsely pitted by the weathering out of the invisible crystals than at the R. R. cut. Indeed the banding that simulates that of sedimentation, consists in finely pitted belts on the surface of the rock alternating with non-pitted bands. The dip, if this structure be due to original sedimentation, is N. E. about 45° in amount, as evinced by a thin layering that slopes in that direction, and which has a tendency to split in beds from one inch to six inches thick coincident with this banding. The rock here also contains chalcedony nodules and is scatteringly porphyritic, resembling thus the pieces found in the upper portion of the conglomerate, No. 825.

The rock that forms the rapids in St. Croix river, half a mile above the town of Taylor's Falls, is essentially the same as that in the R. R. cut, but is less coarsely and conspicuously pitted by the weathering and decay of the invisible crystals supposed to be pyroxene. It is more frequently supplied with quartz, either white or chalcedonic, than the other, and is also striped with red granite, or at least with a red mineral in blotches and vein-like deposits like flesh-red orthoclase, which is also mingled with white quartz. Along the river gorge this rock weathers and crumbles globuliferously, much like the trap-rock seen on the north shore. It has a course and irregular jointage, and sometimes a conchoidal fracture. It is not truly basaltic, even in the Dalles, like the basalt of Grand Marais; yet there are in some places frequent perpendicular joints that divide it into columns. These are cut nearly horrizontally by other joints. Hence coarse columns result from weathering, which are broken horizontally into cuboidal or rhomboidal masses. The banding which looks like sedimentation, near Mr. Folsom's, does not appear generally,—indeed is not known to occur at any other place.

827. From the lower portion of the conglomerate, showing the contained pebbles and the matrix which seems to be of the nature of igneous rock, from the top of the hill east of the R. R. crossing of the highway.

828. Samples of the finer part of this conglomerate where the cement is not igneous, from the same place.

Concerning this conglomerate certain things can be definitely stated, viz:

1. It is extensive, and spreads widely northwestward, even rising to the tops of the hills toward the shaft sunk by Mr. Taylor. It appears in the street, and in the yard of W. H. Cummings, where it is so firm and bold in its outlines, as to appear to be of the real trap formation of the region.
2. It contains waterworn boulders and trap of the region, some of them being porphyries and some not, thus showing the agency of water in its origin.
3. The cementing material is, in the main rock, very much like the boulders, but finer-grained, and sometimes amygdaloidal, thus indicating a possible igneous agency in the origination of thhse parts.
4. It is coarser in its composition near the trap-rock outcrops than at a distance from them; yet the superposition of the conglomerate on the trap cannot actually be seen.

A short distance above Taylor's Falls, at an old quarry in the bluff of the river, the upper part of the conglomerate is so fine as to make a regularly bedded rock about twelve feet thick, and passes for a sandrock. It here contains *Lingulæ*, (*Discina?*) and an occasional small trilobite. Below it becomes coarser and embraces half-rotted pebbles and boulders from the trap. The matrix here also contains grit, some of the pebbles also being of quartz.

On the Wisconsin side the trap is in outcrop in a large ridge about four miles below Franconia, along the road to Osceola. At Franconia the sandrock runs down to the level of the river; near the bottom it is greenish-blue and shaly, and sheds water. This shaly impervious stratum extends down the shore below Franconia, and is visible along near the water-level on the west side of the river, rising sometimes ten feet above it. On Lawrence creek, near the Franconia Mills, is a bluff which overhangs, on account of the crumbling out of the loose sand below. In the crumbling part are numerous laminations of bluish shale which cut the sand into lenticular beds or patches, and the sand itself is cross-bedded. In the crumbling sand are thousands of little *Lingulæ*, and *Discinæ*.

829. A mile and a half below Franconia is an isolated bluff, rising 45 feet above the river, composed of the curious conglomerate seen at Taylor's Falls. It here presents the same mingling of characters that may be referred to igneous and sedimentary origins. The great mass consists of trap boulders, considerably rotted, some of which are as large as a barrel. In the coarser portions of the conglomerate the cementing material is a finer conglomerate of pebbles of the same kind of rock, and in other portions it is a fossiliferous ferruginous, gritty or magnesian sediment, the fossils of which are the same as those seen in the crumbling sand at Franconia, and sometimes apparently an amygdaloid. The change that has taken place in the original structure of the conglomerate by partial decay, and perhaps by heat, makes it often difficult to distinguish between the pebbles and boulders, and the cementing material. The lower portions, if any, are those that seem to have been cemented by the action of heat. A specimen was here obtained of an amygdaloidal part (of the cement ?) which contained fossil shells within less than half an inch of the amygdaloid, both of which, were it not for the contradiction involved, would be pronounced to belong to the cementing material.

In conclusion, judging from the facts here recorded, this conglomerate shows evidences of some kind of metamorphic action in its lower portions, but the phosphatic shells penetrate far down into it and occur even amongst the metamorphic characters. The evidence that this conglomerate was formed under water, even its lower portions, consists in the rounded forms of the contained boulders, while the aqueous conditions of the upper portions are plainly shown by the shells, and by the fact that further up in the formation it graduates to a fine conglomerate and to dolomitic sand rock. (Samples 829 represent some of the finer portions of the conglomerate.)

830. At Sioux Falls, Dakota, may be seen a light-colored schist, of a talcose character, and pea-green color fading to nearly white, similar to that seen at Baraboo in connection with the quartzyte bluffs. It here lies in the rock and becomes a white catlimite. Below the present level of the water of the dam, but formerly exposed above the water, is a layer of white, or pinkish-white catlinite, four feet thick, embraced in the rock that produces the falls.

831. Samples of spotted-red quartzyte, like that at Sault Ste Marie, Michigan, and like some parts of the Fond du Lac sandstone, showing a probable identity of the geological horizons at those places. It is

possible that these light-colored spots are caused by the absorption of the iron through chemical change, and that by careful examination the cementing material would be found to be feldspathic.

The red quartzyte formation at Sioux Falls dips 6 to 8 degrees to the south. The beds are purple within, especially the thick ones, but toward the outside, and along the joints, they are changed in color to a rose red, or a pinkish red. None of the brick-red, heavily iron-stained color can be seen. The change that takes place by weathering not only changes the color but also the hardness, so that the rock goes into a loose sandrock again and crumbles in the hand. This takes place to so large an extent that in suitable places it is gathered and used for mortar. There are also some beds that are wholly now, (so far as can be seen) in this friable condition. The sand that results is a pure selica, nearly white, and translucent, though it is apt to show at first a slight pinkish tint rising from the remains of the cement among the grains. There is visible here, of the bedding, fifty feet, (estimated) and the river goes over the beds from south to north, producing a fine water power. In one place there is a gorge fifteen feet high and from seventy-five to eighty feet wide.

832. Spotted (amygdaloidal ?) samples of the brick-red quartzyte from Redstone, near New Ulm.

833. Red shale, the lowest rock seen in the R. R. cut at Redstone. This is four or five feet thick, the upper portions being rather slaty and tough. Some of the higher layers are sandy from disintegration as at Sioux Falls, and some are hard and quarzitic, and all are of a darker red color. Some beds are spotted, perhaps from an incipient amygdaloidal structure. Mr. Nicholas Thinnes, who first opened the quarry at Redstone in 1857, avers that some of the rock of the formation here is "granit," the same as some of that at Little Rock, a fact which, if verified, will unite the formation with that, and will show its analogy to those tilted red semi-crystalline beds in the northern part of the state (V. Nos. 783 to 785.) But this crystalline structure has not been seen at Redstone by any member of the geological survey.

834. Slab of red quartzyte from Sioux Falls, showing the finely pitted exterior of the individual sand grains on the removal of the white schist, No. 830.

835. Gray, coarse-grained granite, in color much like the gabbro at Duluth, from the E. St. Cloud quarries. This was formerly used in connection with the rocks 803 and the finer grained gray granite like that at Sauk Rapids indiscriminately for construction, but owing to its large content of quartz, it has been abandoned for those varieties

more easily wrought. All these sorts are to be seen in the trimmings of the Custom House at St. Paul. But that now generally used is to be seen in the trimmings of the New Union Depot, at the same place.

836. The pink quartzyte known as the "jasper rock" locally, from Sioux Falls, Dakota. This is a pinkish granular quartzyte, but with a cement that, on disintegration, allows the rock to become a white sand.

III.

THE POTSDAM SANDSTONE.

It is well known that geologists are not agreed on the question: "What is the western representative of the Potsdam sandstone of New York State?" The correct determination of this interesting problem has an important bearing on the interpretation of the stratigraphy of Minnesota geology, inasmuch as all the different horizons involved in the investigation are widely represented in the State. Those horizons are as follows in descending order:

1. The light-colored sandstones seen in the Mississippi river bluffs, and the bluffs of the St. Croix, from Taylor's Falls to Winona, containing species of *Lingulæ* and trilobites, generally distinguished by this survey as the *St. Croix Sandstone.*

2. The red and light-colored horizontal sandstones that bound the south shore of Lake Superior throughout most of Wisconsin, and much of Michigan, extending from Sault St. Mary to Fond du Lac, holding fucoids and *Scolithus.*

3 The red sandstones and shales, with the associated conglomerates that are involved with the trap-rocks of Lake Superior, furnishing metallic copper, lately known as the *Keweenian formation.*

At different places Nos. 1 and 2 have been seen unconformably overlying portions of No. 3, and in others No. 3 has been seen passing into No. 2, or at least into a sandrock that was taken for No. 2, while No. 2 itself seems to be the equivalent of beds that in other places represent No. 1.

While it is perhaps impossible at this time to state which of these three, or which two of these three, have the greater amount of evidence in their favor, it will conduce to the progress of the investigation to ascertain and collate some of the facts that bear on the geology of this disputed terrane, and to review briefly the progress of opinion and investigation in the Lake Superior region. In the light of late explorations in the West, and of late investigations in the East, perhaps it will be possible to reach more nearly a correct conclusion than at any other time. In the first place it will be well to summarize the opinions held by different geologists who have expressed any opinions respecting the Potsdam sandstone of the West. There was a school of geologists between 1840 and 1858 who regarded the Lake Superior sandstones as not of the Lower Silurian, and some are found even to this day. They were not united among themselves, but were divided between Jurasso-Triassic, Devonian, Upper Silurian and Carboniferous. After the investigations of Dr. D. D. Owen and the report of Foster & Whitney, unprejudiced geologists very generally accepted the conclusion that they are of the Lower Silurian, and lately the facts recorded by Dr. C. Rominger seem to place their Lower Silurian age beyond doubt. Thus the question is brought within narrower limits and the doubt that still exists pertains only to their exact horizon in the Lower Silurian, or in other words, where in the West the Potsdam sandstone is found. It was until lately that the same uncertainty existed within the limits of an individual State, respecting the equivalency of beds in the Carboniferous age as they extended from one side to the other,* and the problem was finally settled by tracing a well-known sandrock formation from north to south, and bringing all the other strata into order above and below it. Perhaps some such process may be applied to this question.

But before entering upon that a glance may be taken at the various opinions that have been held. These opinions may be grouped under sixteen heads, but the present state of knowledge compels us to ignore many of these opinions, which reduces the groups to be considered to ten. The sixteen groups are as follows, with the names of those who have advocated them:

Summary of Opinions.

1. Those who regard No. 1 as the Potsdam sandstone – Logan, White.
2. Those who regard No. 2 as the Potsdam sandstone—Logan, Brooks.
3 Those who regard No. 3 as the Potsdam sandstone—Rogers (W. B.), Dana, Winchell (N. H.).
4. Those who regard all of them as the Potsdam sandstone—Hall, Foster, Whitney, Winchell (A), Dana, Kloos, Owen.
5. Those who regard Nos. 1 and 2 as the Potsdam sandstone—Whittlesey Chamberlin, Irving
6. Those who regard Nos. 2 and 3 as the Potsdam sandstone—Hubbard, Rivot, Rogers (W. B.), Whittlesey, Marvine, Rominger, Wadsworth.
7. Those who regard the Lake Superior sandstones as Calciferous and Potsdam —Dana.
8. Those who regard the sandstones of Lake Superior as Calciferous—Dana.
9. Those who regard the Lake Superior sandstones as Potsdam, Calciferous and Chazy—Logan.

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*Ohio.

10. Those who regard the Lake Superior sandstones as Quebec—Logan, Hunt, Pumpelly, Dana, Hall.

11. Those who regard the Lake Superior sandstones as Jurasso-Triassic—Houghton, Ruggles, Jackson, Shepard, Rogers (H. D.), Owen, Marcou, Dana, Bell (or Permian).

12. Those who regard the Lake Superior sandstone as Upper Silurian—Jackson.

13. Those who regard the Lake Superior sandstone as Devonian—Locke, Bigsby and Bayfield.

14. Those who regard the Lake Superior sandstones as Permian MacFarlane.

15. Those who regard the trap and sandstones of No. 3 as Cambrian—Logan, Bigsby (Whittlesey older than No. 1).

16. Those who regard the trap and sandstones of No. 3 as Huronian—Selwyn.

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Opinion No. 2. Geological survey of Canada. Rep. for 1846-7; American Journal of Science, 1852, XIV, 226; Geology of Wisconsin, 1873, III, 433.

Opinion No. 3. Proc. Bos. Soc. Nat. His., 1860, VII, 394; Rep. Minn. Survey, 1872, 68; *Ibid* 1876, 29; Dana's Manual of Geology, edition 1862, p. 173 74.

Opinion No. 4. Palæontology of New York III, 79; Report on the Geology of the Lake Superior Land District, Part II, p. 137; Proc. Am. Assc. Adv. Sci., 1851, V., 22-38; Am. Jour. Sci., 1864, XXXVII, 226; Sixteenth Regents' Report N. Y. State Cabinet, p. 119; Dana's Man. Geol., 1862; Geologische Notizen ans Minnesota, Zeit. d. deut. geol Gesell, 1871; Owen's Report on the Geology of Wisconsin, Iowa and Minnesota, 1852; Proc. Am. Assc Adv. Sci., 1855, X., 204; Leonhards' Jahrbuch, 1877, Erstes Heft, pp. 31, 113, and 225.

Opinion No. 5. Geology of Wisconsin, 1873, III; Geol. Wis., Iowa and Minn , 461.

Opinion No. 6. The Mineral Regions of Lake Superior, by J. Houghton, Jr., and T W. Bristol; Senate Documents, 1849-50, 31st Cong., 1st Sess , III, p. 802, 842; *Ibid*, 1845-6, 29th Congress, 1st Sess., VII No. 357, p. 2–29; Annales des Mines (5) 1855, VII, 173; 1856, X, 364; Proc. Bos. Soc. Nat. Hist., 1860, VII, 394–399; Proc. Am. Assc. Adv. Sci., XXIV, 1875, 60; Mineral Regions of Minnesota, 1866; Geology of Michigan I, Part II, 1873; *Ibid* Part III; Proc. Am. Assc. Adv. Sci. XXIX, 429.

Opinion No. 7. Dana's Man. Geol. 1862, pp. 172-74.

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Opinion No. 11. Am. Jour. of Sci. (1), XLIX, 62-72; *Ibid*, p. 81-93; Assc. Am. Geol. and Nat., 6th meeting, 1845, p. 53; Bul. Soc. Geol. France, 1850-51 (2), VIII, 101; Geology of North America, by Jules Marcou, Zurich, 1858, p. 64; Rep. on

Chip. Land Dist., 1848, pp 57-58; Sen. Docs., 1847-48, VII, No. 57, p 134; Am. Jour Sci., 1843 (1), XLV, 160; Proc. Bos. Nat. Hist., 1864, II, 124; Dana's Manual of Mineralogy, 2nd Ed., 1857, p. 305; Rep Progress Geol. Sur. of Can., 1866-69, p. 321.

Opinion No. 12. Proc. Bos. Soc. Nat. Hist , III, p. 335.

Opinion No. 13. Quar. Jour. Sci. Lond., 1824, XVII, pp. 1-34, 228-269; Am Jour. Sci., 1824 (1), VIII, 60-88; Trans. Lit. and Hist., Soc. of Quebec, 1829, I, p. 1; Locke's Beport, 1847.

Opinion No. 14. Can. Nat. and Geol. (2), III, p. 256.

Opinion No. 15. Trans. Brit. Assoc. Adv. Sci., 1851; Edin. New. Phil. Jour. LIII, 55; Geol. Wis., Iowa and Minn., 461.

Opinion No. 16. Can. Nat. and Geol. (2), IX, 17; Rep. Prog. Can. Geol. Sur., 1877-78.

If we discard those whose opinions make the Lake Superior sandstones post-Silurian, and also those who regard them as pre-Silurian, of the remaining, by far the greatest weight of authority falls on proposition No. 6, which assigns Nos. 2 and 3 to the Potsdam. Proposition No. 4, which assigns them all to the Potsdam, follows next in weight of authority.

In this enquiry it will be necessary in the first place to ascertain exactly what the Potsdam sandstone is stratigraphically, lithologically and palaeontologically. This will involve an enquiry into the nature of the formations that lie below and above it in New York and New England Secondly, it will be necessary to ascertain what formations in the West approach most nearly to an equivalency with the same horizons.

1. What is the Potsdam of New York and New England? As to the lithological characters of the Potsdam in New York the following is from the annual report of Dr. E. Emmons, Jan. 1838: "This rock is a true sandstone, of a red, yellowish-red, gray and grayish-white colors. It is made up of grains of sand, and held together without a cement. Inter-mixed with the siliceous grains are firner particles of yellowish feldspar which do not essentially change the character of the sandstone, but show the probable source from which the materials forming it were originally derived, viz.: some of the varieties of granite. Unlike, however, most of the sandstones, it is destitute of scales of mica. The coloring matter of the rock is evidently oxide of iron, but unequally diffused through it, giving it intensity or deepness of color according to its quantity. In some places it is almost wanting, which makes it, when pulverized, a good material for glass. The grains and particles in its composition are generally angular, but where it takes the character of a conglomerate, as it does in the inferior layers, they are frequently rounded. The thicker strata exhibit an

obscurely striped appearance, owing to the prevalence of certain colors in the different layers." In his final report on the agriculture of New York Mr. Emmons says of this rock: "This sandstone is more uniform in its characters than most of the individual rocks in the series. At Potsdam it is yellowish-brown; at Moira and its neighborhood, and also in Mooers, it is nearly white and sandy; at Chazy it is of a deep red at the bottom, and gray towards the top, while at Whitehall, Corinth, Hammond and near Glen's Falls it is gray, and more or less crystalline. In many places it is a coarse conglomerate, as at Mooers in Franklin county, and at DeKalb in St. Lawrence county. It is of course a siliceous rock, yet it does not exclude other substances or elements; for, a true sandstone, far from being composed of pure siliceous sand, admits into its composition mica and feldspar, oxide of iron, and probably even a greater variety of the primitive minerals, as hornblende, pyroxene, &c., in a state of fine division."

Mr. Mather, in his final report on the first district, speaks of the Potsdam in the following terms: "The Potsdam sandstone is a hard siliceous sandstone, white, red, gray, yellowish, and frequently striped. It is well developed at Whitehall." * * * * "Some of the strata of this rock are covered with the most beautifully characterized ripple-marks, as perfect as if just formed on the sand of a sea beach, while the rock is of the most indurated kind of sandstone." * * * * "Fucoidal impressions are also seen in some of the strata of this rock. * * * * "It is a hard stone to dress, and is one of the most durable kinds of rock." * * * * "In some places, in its lower part in particular, it is a metamorphic rock, having more or less the aspect of gneiss, except that mica is absent. Half a mile west of Putnam's Ferry, where it overlies granitic rocks, it is in an intermediate state, having the general aspect of a primary rock, but still shows its rounded gravel and sand." Mr. Mather mentions other places where it has been changed by metamorphic agency. In the northwest part of Clinton county, and in St. Lawrence and Franklin counties the lower portion of the Potsdam is a conglomerate, which in some places reaches the thickness of 300 feet.

Where the formation appears in Vermont it runs in mono-clinal, long or short, sharp ridges, and is thus spoken of by Dr. Edward Hitchcock in the first volume of the final report on the geology of Vermont, 1861: "Its lithological characters vary very little. In consequence of a metamorphic action we reckon three varieties:

1. Pure siliceous sandstone.
2. Hornblende schist.

3. Gneiss.

"The first of the trio is what is universally known as Potsdam sandstone, a hard, compact, thick-bedded sandstone, and perfectly homogeneous in structure, unless metamorphosed. Its color is generally white in the eastern part of North America; it being red upon the shores of Lake Superior." * * * "The second variety cannot be distinguished from the hornblende schist which occurs among the azoic rocks of Vermont and New York." * * * * "The third variety very closely resembles the Laurentian gneiss. It seems to pass into it by insensible gradations. All the constituents of this rock are very small, and occasionally the feldspar or the mica may be wanting. These hornblende schists and gneiss rocks, indicate a change has passed over a part of the Potsdam sandstone, analogous to the metamorphism that has so obscured the rocks of eastern Vermont; for such rocks as gneiss, &c., are not found, except by the crystallization of the constituent minerals after the accumulation of the sediments." Dr. Hitchcock also mentions veins of "granite" in the Potsdam at West Haven, whose feldspar is labradorite. At the time of Dr. Hitchcock's report the "red sandrock" of Vermont was not admitted within the Potsdam, nor was the "quartz rock" running along the western base of the Green mountains, but an earnest discussion was then going on between Professors Hall, Dana, Emmons, Marcou, Billings, Logan and others, concerning the geological position, and the actuality of any such system as had been designated Taconic, claimed by Prof. Emmons to lie directly below the Potsdam: *Vide* Am. Jour. Sci , 1861, No. 91; and Can. Nat. and Geol., 1861, Vol. VI, p. 106.

2. As to the palæontology of the New York typical potsdam. Prof. Hall reports in the first volume of the palæontology of New York, besides *Scolithus linearis*, two spieces of *Lingulæ*, viz: *prima* and *antiqua*. To this list have been added since a species of *Hyolithes* from Keeseville. Am. Jour, Sci., July 1871, p. 32; 1873, p. 211, vol. 5; imperfect specimens of supposed *Pleurotomaria* and *Conocephalites minutus*, from Keeseville. The last may belong to the beds below the Potsdam, as described by Brooks, Am. Jour. (3) IV, 22. In the state of Vermont have been discovered several species of trilobites, as well as other species of trilobites and brachiopods at Troy, N. Y., (Am. Jour. Sci., 1873, vol. VI, p. 134; vol. XI, 1876, p. 369.) But as their position in the formation is still in doubt, while some of them, especially those from Georgia, Vt. and Troy, N. Y., have been shown to belong below the Potsdam in statigraphical sequençe, none of them should be embraced in the fauna of the typical Potsdam. At the same time the term Potsdam

has been extended loosely over these strata, especially by those who are adverse to the Taconic group of Emmons. (Am. Jour. Sci., 1880, vol. XIX, p. 152; Ibid, 1880, vol. XIX, p. 153 and p. 225.)

3. One of the results of the Taconic discussion was the establishment of the essential correctness of Prof. Emmons' claim, that beneath the Potsdam sandstone was still a fossiliferous horizon, which when metamorphosed constituted the roofing slates and talcose rocks of eastern New York and northern Vermont, though he perhaps extended it without warrant over areas where he had not sufficient evidence of its actual continuance. This error however, no more invalidated his claim to the correct establishment of his system than a similar supposed error in the extension of the Hudson River rocks where they were not proven to exist in Vermont, Massachusetts and eastern New York, destroyed that system. Geol. Wis., 1862, p. 443; Proc. Am. Ass. Adv. Sci., 1877, XXVI, p. 259. The palæontological investigations of Mr. Billings, seconded by Mr. Barrande, and of Mr. Ford, have amply demonstrated that beneath the horizon of the Potsdam sandstone is a series of rocks containing a primordial fauna, consisting of argillaceous slates, black slate, and thin-bedded sandstone with some limestone. This formation, sometimes known as the Georgia Group, is probably the equivalent of the Acadian of Dawson. According to Brooks, these strata, as they occur at Keene Station in St. Lawrence Co., N. Y., consist of magnesian schists, crystalline limestone and sandrock like the Potsdam but containing beds and veins of granite, the whole amounting to a mininum thickness of 700 feet, (Am. Jour. Sci. (3) IV. 22.)

4. ,The fossil species, described by Mr. Ford from these lower Potsdam, or Taconic rocks near Troy, N. Y., are sixteen, and a portion are identical with fossils from the Acadian. On the strength of palæontological differences Mr. Ford states that he considers these beds to occupy a lower geological horizon than the typical Potsdam of New York, and to be of nearly, if not exactly, the same age as the Georgia slates of Vermont, and the limestones on the north shore of the straits of Belle Isle. The fauna he regards "wholly distinct specifically from that of the upper Potsdam of Wisconsin and the true Potsdam of New York," (Compare Am. Jour. Sci., (3) XIX, 152.) After Mr. Barrande had indicated the primordial character of the trilobites of the Georgia slates, and Messrs. Billings and Logan had accepted his suggestion. Prof. Hall also recognized the strength of palæontological authority and admitted that the Potsdam of the New York survey was not the true primordial base. This true primordial zone is

characterized in America by such trilobites as *Paradoxides*, *Conocephalus*, *Arionellus*, *Conocoryphe*, and *Olenellus*.

5. If we next inquire what formation lies above the New York typical Potsdam, we shall find the Calciferous Sandrock described by Prof. Emmons as follows:—(Final Rep.) "Considered as a totality this is one of the most heterogeneous rocks in the New York system. That part which furnished the name is well designated under the descriptive term, and is easily recognized." This is a gray mass with sparkling grains of lime, but an impure limestone, being mechanically mixed with fine grains of sand and slight interlaminations of argillaceous matter. Another variety is a fine-grained and blue limestone, and another is red or chocolate colored, consisting of sandstone slightly interlaminated with shale.

Mr. Mather thus designates this formation: "The rocks are calcareo-siliceous, and sometimes one and sometimes the other predominates, and gives character to the rock. The water-lined laminæ of deposition are very conspicuous in some of the strata of the Calciferous sandstone. * * * * There are numerous small patches where these rocks have been upheaved and exposed, that are not continuous for any considerable distance * * * *, having been fractured across and heaved out of place along faults transverse to the lines along which the *principal* disturbances have taken place." This formation in N. Y. lies under the Chazy limestone.

6. The fossils of the Calciferous in New York, as reported by Prof. Hall in the first vol. of the palæontology of New York consist of the following:

Two species of *Palæophychus*.

One species of *Buthotrephis*, *Lingula acuminata*, *Euomphalus uniangulatus*.

Two spiecies of *Maclurea*.

Two species of *Ophileta*.

Two species of *Turbo*.

Pleurotomaria turgida.

Two species of *Orthoceras*.

To these Mr. Billings has added very many species from the adjoining portions of Canada, including gasteropods, brachiopods, and cephalopods. Of trilobites are fourteen species referred to the Calciferous, viz.: two of *Amphion*, six of *Bathyurus*, one of *Asaphus*, and others of *Agraulos* and *Conocoryphe*. The rocks of the Quebec group, which are placed by Prof. Dana above the Calciferous, seem to embrace both stratigraphically and palæontologically, the whole range of beds from the base of the *second fauna* to the top of the Chazy; and over two hundred and twenty species have been described from this group. But their relation to the Potsdam is still a matter of doubt. While stratigraphically they are placed above the Potsdam by Billings, Logan, Dana and Hall, they still have many of the species that have been reported from the western so-called Potsdam, viz.:

Four species of *Leptæna.*
Fourteen species of *Orthis.*
Three species of *Lingula.*
Two species of *Obolella.*
Two species of *Stricklandia.*
Two species of *Ecculiomphalus.*
Seven species of *Pleurotomaria.*
Two species of *Murchisonia.*
Three species of *Ophileta.*
Two species of *Holopea.*
Seven species of *Metoptoma.*
One species each of *Helicotoma* and *Maclurea.*
Seven species of *Orthoceras.*
Six species of *Cyrtoceras.*
One specie of *Nautilus.*

TRILOBITES.

Three species of *Agnostus.*
Two of *Arionellus.*
Two of *Asaphus.*
Eight of *Bathyurus.*
Two of *Cheirurus.*
Eight of *Dickelocephalus.*
Three of *Menocephalus.*

And one each of *Amphion, Amphyx, Conocephalites, Holometopus, Illænus, Nileus, Shumardia* and *Leperditia.* Mr. C. D. Walcott has also lately found the following new species in the Calciferous in Saratoga county, New York, viz.: *Platyceras minutissimum, Metoptoma cornutaforme, Conocephalites calciferus, Conocephalites Hartii, Ptychaspis speciosus* and *Bathyurus armatus*, of Billings. He remarks that "the occurance of a species of the genus *Ptychaspis,* associated with *conocephalites calciferus* and *C. Hartii*—species related to *Conocephalites Wisconsensis* and *C. Iowensis* of the Potsdam fauna of Iowa and Wisconsin—relates the fauna of the Calciferous formation of New York with that of the Potsdam sandstone of Iowa and Wisconsin."

We have now stated the essential features and the stratigraphical position of the typical Potsdam sandstone of New York, as given by the best authorities, and it will be best to recapitulate briefly.

1. It is a red or gray loose sandstone, often tilted or faulted, also metamorphozed, and then having the name of quartzyte.

2. It contains but very few fossils, three undoubted species being the most that can be referred to it, but not distinctly primordial.

3. It is underlain by a series of black slates and sandstones, with some limestones, which have exhibited in Vermont, at Troy, N. Y., and at the Straits of Belle Isle, a decidedly primordial type of life.

4. It is overlain by a formation which exhibits but few fossils in New York, but which in Canada holds a diversified fauna, placed by Barrande, Billings and Logan near the bottom of the second fauna, containing, among other species, numerous genera of trilobites.

If in the same manner the formations of the Lower Silurian in the west that may possibly be the equivalents of these three of New York, be reviewed, some light may be thrown on the question of the parallelism of the New York Potsdam in its western extension.

1. The lowest formation known in the northwest, which may be parallelized with the foregoing, is that which Sir William Logan denominated at first the "Lower Volcanic Group," and subsequently the "Kaministiquia Slates," and which Dr. T. S. Hunt has named the "Animikie Group." It is the same as that which contains the silver mines of the northwest shore of Lake Superior. It is briefly described in the Seventh Annual Report of the Minnesota Geological Survey. It consists emphatically of slates, but it contains many beds of gray quartzyte, and some of dolomite. It passes downward to the Gunflint beds of northern Minnesota, and *seems* to lie unconformably on the formation that has been accepted as the Huronian. It is cut by igneous dykes, and is interbedded with what appears to be a diabase rock. No fossils have been found in it. The slatiness of this formation is due to the horizontal sedimentary lamination, so far as seen, and not to a superinduced cleavage. The extent of this formation northwest of Lake Superior is unknown toward the north but it extends east and west at least one hundred and twenty-five miles. It is believed to occur in Michigan and Wisconsin, since mention has been made in geological reports of those States of a "black slate" in the Potsdam formation. Proc. Am. Assc. Adv. Sci., IX, 208; the Mineral Regions of Minnesota—Whittlesey, 1866, p. 4. Stratigraphically this seems to occupy the place of the Taconic rocks at Troy, N. Y., and of the Georgia Group of Vermont. Lithologically it has a close resemblance, and

palæontologically the evidence of parallelism is simply negative, *i. e.*, as no fossils have been found in it, no comparison can be made on that basis.

2. The foregoing formation is overlain by the Cupriferous rocks of Lake Superior (No. 3 above), whether conformably or not is not known, but so far as the evidence goes it appears in Minnesota to graduate into the overlying formation conformably, and unconformability is not reported by the Canadian geologists at Thunder Bay. This formation is pretty well known, so far as its associated igneous rocks are concerned, and the equivalency of its sedimentary portions with the Potsdam has been the subject of much discussion. A summary of opinions has already been presented. It is only necessary here to mention its outward characters, and to compare them with the three formations of New York, to each of which it has been referred by different geologists.

It is a red formation of shale, sandstone and conglomerate, metamorphozed by igneous upheaval and fracture, locally changed to gneiss, syenite and hard, red quartzytes, and is interbedded with doleryte and mixed with gabbro. In it have been seen only the non-characteristic *Fucoides*, but its association with repeated igneous outflow is sufficient reason for the non-existence of animal life in the era of its deposition. Still if the sandstones of Tequamenon Bay in Michigan be considered its equivalent it may be said that two species of *Lingula* have been taken from this formation. Dr. Rominger, however, who has carefully examined the Upper Peninsula of Michigan, unhesitatingly places these in conspicuous formation, as he also does the bed of breccia containing the *Dikelocephalus* on the Menominee river near Grand Rapids —Geol. of Mich., vol, I, Part III, pp. 73 and 80. The beds at Marquette containing *Pleurotomaria* are placed by Mr. Billings in the Calciferous.

The lithological characters of this formation, therefore, ally it unmistakably with the typical sandstone of Potsdam, while stratigraphically it lies above a similar series of black slates and sandstones as in eastern New York and Vermont. If it be borne in mind that the typical Potsdam has a very meager fauna, consisting of but three species not characteristic of that horizon, it has a very close resemblance in its fauna also; and it is not unreasonable to suppose that when this horizon in the northwest has been as minutely examined as the typical Potsdam has in New York, an equal number of *Lingulae* may be found in it.

3. It is the overlying formation, however (Nos. 2 and 1), which af-

fords the best material for comparison with eastern rock horizons, as it is marked by a fauna very diversified and characteristic, and is easily traced, by a series of explorations by competent geologists, from the Mississippi river to Canada, with no very important interruptions, making a very close connection with an allied, if not an identical, formation in eastern Canada. Here are placed in one formation the foregoing Nos. 2 and 1, not because there is certainly any line of separation between Nos. 2 and 3, nor the absence of one between Nos. 2 and 1, but because on comparing the described characters of 1 and 2, they seem to occupy nearly the same geological horizon, and for the present purpose can best be considered as one. They consist of light-colored siliceous sandstones with some dolomitic layers near the top. They are horizontally stratified, and are seen in different places to lie unconformably upon the tilted layers and trap rocks belonging to No. 3—or the copper-bearing rocks. This is the case at Taylor's Falls, Minn., and at Kewenaw Point in Michigan. While it would perhaps be an arbitrary line which should set them off as a distinct formation from the copper-bearing series, they still need to be distinguished from that series on account of great lithological differences and stratigraphical position, as well as on account of the rich fossil fauna they have afforded. The fossils that have been described from the bluffs of the Mississippi and St. Croix rivers by Dr. Owen (Geol. Wis, Iowa and Minn.) and by Prof. James Hall (16th Regents' Report) are all from this formation, and it requires but a glance to see their resemblance to that fauna which has been found in Canada and described as in the Quebec group. These fossils, as enumerated by Prof. Hall in the 16th N. Y. Regents' Report, are as follows:

Five species of *Lingula.*
One species of *Lingulepis.*
One species of *Discina.*
One species of *Obella.*
One species of *Orthis.*
One species of *Platyceras.*
One species of *Euomphalus.*
One species of *Theca.*
One species of *Serpulites.*
One species of *Sendrograptus*
And of *trilobites* the following:
Six species of *Dikelocephalus.*
Eighteen species of *Conocephalites.*
One species of *Arionellus* (?).

Three species of *Ptychaspis.*
One species of *Chariocephalus.*
One species of *Illaenurus.*
One species of *Triarthrus.*
Three species of *Agnostus.*
One species of *Aglaspis.*
One species of *Pemphigaspis.*
One species of *Amphion.*

With such an array of identical genera, not to say species, it is safe to assume identity of geological era for these strata with those containing such a fauna in Canada—Pal. Fossil, p. 198; Am. Jour. Sci. (2.) XXXI, 222. It is to be admitted that these fossils have not yet been discovered in the arenaceous strata extending through northern Michigan, although the same friable formation, occupying the same stratigraphical horizon, extends from Wisconsin to the east end of Lake Superior, and has been traced by Prof. Chamberlain and Dr. Rominger. They are there kept constantly distinct by Dr. Rominger, from the underlying red sandstones, which he says are generally firm, and become disturbed by igneous upheavals in their lower portion. The sandrock, cut by the canal at Sault St. Marie, he says is the lower red sandrock.[*]

To what eastern formation this fossiliferous belt may finally be assigned, whether to the Quebec or to the Potsdam, it certainly shows the palæontology of the Quebec; but at the same time Prof. Hall has cautiously assigned it to the Potsdam of New York. He has also assigned the sandstones of No. 3 and No. 2 to the same, and his authority, therefore, to a great extent, nullifies itself.

It seems, therefore, that so far as present available information will warrant us in coming to a conclusion, we can accept the following as probable if not certain:

1. The Taconic Group was correctly established by Prof. Emmons, though its limits, stratigraphically and geographically, were at first wrongly defined by him.[†]

2. The Georgia Group of Vermont, and the Animikie Group of Thunder Bay, and the Acadian of New Brunswick, are the equivalent of the Taconic of Emmons.

3. The Taconic has the true primordial fauna of Barrande.

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[*] See Hunt on the identity of the Calciferous and Western Potsdam, Can. Nat. and Geol. (3) VI, 87; Azoic, Rocks of Penn. 1878. Report E., pp. 107 and 108.

[†] Compare Dana's investigation of the so-called Hudson River Group, in Mass., Vermont and New York. Am. Jour. Science, various papers in 1872—80.

4. The Potsdam, which lies conformably above it in the east, is represented by the rocks of the copper-bearing series in the west.

5. No fossils, representing the true primordial fauna, have yet been discovered in the west, nor have any been found in the western representative of the Potsdam.

6. The "second fauna" of Barrande is found in the Quebec group of Canada, and in the St. Croix sandstone of the west, lying in each case above the Potsdam sandstone.

IV.

TYPICAL THIN SECTIONS OF THE ROCKS OF THE CUPRIFEROUS SERIES IN MINNESOTA.*

By N. H. WINCHELL.

In northern Minnesota the cupriferous rocks, when crystalline, consist of two distinct types. One serie is *igneous*, and one is *metamorphic*.

The former may be broadly comprehended under the term *doleryte*, as defined by Prof. J. D. Dana. The most frequent representative of this group is the rock gabbro, consisting essentially of labradorite, augite and titaniferous magnetite. It produces the dark-colored and heavy rocks of the shore, is seen as layers alternating with the non-crystalline and sub-crystalline layers of the other group, and as massive, mountain-like elevations. It is often basaltic. On weathering, it decomposes and becomes greenish when near the water, but brownish when at higher elevations. It is often amygdaloidal, furnishing various zeolitic and other minerals. It has a very intimate, and yet very distinguishable association with the rocks of the other group; but in general it is the most conspicuous rock of the cupriferous series, causing the most of the salient features of the coast, and the prominent elevations of northeastern Minnesota. When in contact with the sedimentary beds, the rocks of the igneous group are but slightly affected by the interpenetration of the minerals of the other group. Yet in some instances isolated pieces of the sedimentaries have been embraced in the igneous rock, and so completely fused with them, that the minerals, that otherwise characterize each, are closely mingled over small intervals.

The rocks of the second or metamorphic group, on the other hand, are, in nearly all cases, of a reddish color. They show all stages of metamorphic change—from red sedimentary shale and sandstone to red felsite and syenite The minerals that are invariably found in this rock, when completely crystalline, are quartz, orthoclase, and hornblende. The beds from which these crystalline red rocks were derived are seen interstratified with regularity with the rocks of the other group. But when these red rocks are crystalline or subcrystalline, the alternation is less evident. The alternation in this changed condition is less frequently seen in horizontal layers, but rather appears in sudden verticle replacement. In some places they appear to have had a great thickness, and they constitute, in their changed condition, some of the most interesting features in the geology of the north shore. The red felsite of the Great Palisades containing crystals of adularia, which is underlain by a very characteristic doleryte of the igneous group, and penetrated by numerous dykes from it, can be traced, in varied steps, on the one hand to its original condition, a shale of the Potsdam formation; and in the other direction, through step after step of metamorphic change, to a hard crystalline rock of red color and of a granular texture consisting essentially of orthoclase, quartz and hornblende. It is not always possible to observe a continuity of bedding from one extreme condition to the other. The circumstances of upheaval and metamorphism have generally been unfavorable for that. Some of the links are wanting in nearly every series of observations, but they are such as are supplied at other places—such places also failing to show other links. It may be supposed that it is necessary to make a perfectly connected series of contiguous observations, on a rock, *in situ*, changing from step to step, without interruption of the beds by dip or other cause, in order to establish the series; but such is not the case. When it once becomes evident that certain mineral associations are constant, if a part of these associations are observable, the rest may be relied on. When it is understood that there are two great sources of crystalline rock, the igneous and the metamorphic, and some of their related phenomena are established, such established phenomena are indices to show the origin of other new phenomena. Such new phenomena may again be taken in the same way to point others, and these again others. So at last a whole family of phenomena can be grouped together, although at no place can a connected series of all the phenomena be observed. In that manner, step by step, the lithology of the crystalline copper-bearing rocks can be reduced to two series. When these microscopic phenomena are in concord with and are affirmed by the field geology, as in the case on the north shore of Lake Superior, the true solution of some very interesting questions is found. The rocks of the second series, the result of the crystallization of the

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*From the proceedings of the American Association for the advancement of science, Vol. XXX, Cincinnati Meeting, August, 1881.

Potsdam shales and sandstones, are found to occupy a large area in the extreme eastern portion of Minnesota, northeast of Grand Marais, while those of the first series seem to prevail along the shore, and to cause mountain ranges at some distance from the lake.*

The following brief descriptions are intended to give a general idea of the two groups.

(A) ROCKS OF THE IGNEOUS GROUP.

1. (Survey No. 1.) Gabbro, "Duluth Granite." From Rice's Point, near Duluth; the rock of a low mountain range. Contains labradorite and changed augite, the latter being uralitic: also titantiferous magnetite.

2. (Sur. No. 49.) Behind the M. E. Church, Duluth. Contains augite, plagioclase, and magnetite, with viridite and ferrite.

3. (Sur. No. 53.) East Duluth. Coarsely crystalline. Contains plagioclase, augite, magnetite, and delessite, also some chrysolite and biotite. In some places this rock also shows orthoclase, making it resemble No. 5 of the Survey numbers.

4. (Sur No. 90.) From the E. point of Sucker Bay. Contains plagioclase, augite, magnetite, chrysolite.

5. (Sur. No. 113.) Labradorite rock, from masses included in gabbro at Split-rock point.

6. (Sur. No 116.) From the point half-way between Split-rock point and Two Harbor Bay. Shows a basaltic structure. Contains plagioclase, augite, magnetite, viridite, opacite, and an occasional grain of biotite.

7. (Sur. No 123) From the bluff east of Castle Danger; a doleryte, containing plagioclase, augite, chrysolite, magnetite, and viridite.

8. (Sur. No. 126.) This is the rock that furnishes the black sand at Black Beach, a few miles W. of Beaver Bay, one-half mile up the creek. It seems to consist of plagioclase (labradorite?) hypersthene and magnetite, making the rock hyperyte. The metalloidal surfaces of the crystals in this rock resemble those of the rock of Encampment Island.

9. (Sur. No. 128.) Section of a large crystal of labradorite, from masses embraced in gabbro at Beaver Bay.

10. (Sur. No. 141.) Doleryte: first rock east of the Great Palisades, (lies below the Palisades?) Has augite, plagioclase, magnetite, viridite (and biotite?).

11. (Sur. No. 160) The rock that protects Little Marais on the east: plagioclase, augite, magnetite, also hematite and ferrite.

12. (Sur No. 199.) The rock of Grand Marais Harbor; plagioclase, pyroxene and magnetite; hematite, ferrite, apatite.

13. (Sur. No. 200.) Cupriferous gabbro; from N. W. quarter Sec. 24, T. 61, R. 1. W. (up Fall river); plagioclase, augite (diallage?) magnetite, viridite, ferrite. There are thin sheets of native copper disseminated through the mass of this rock.

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*A series of fifty thin sections with samples of the rocks from which they were prepared, were exhibited, and examined at the table by means of polarized light, on a microscope kindly loaned for the purpose by Mr. W. H. Bulloch of Chicago, Ill. They were numbered successively from one to fifty, the first twenty-one being of the igneous group, and the next twenty-one of the metamorphic. The last eight, from forty-three to fifty, were selected to show a mingling of the minerals of both groups in one rock. The samples of rock were numbered in blue shellac with the field number of the survey. The labels attached to the slides name the most evident and abundant of the minerals seen in each, as they have been identified by the writer.

The rock, as a dyke, cuts a rock like that of the Great Palisades—an amorphous, red, but slightly porphyritic orthoclastic felsite.

14. (Sur. No. 221.) From a short distance east of the Brule′ river; plagioclase, diallage and magnetite; coarsely crystalline.

15. (Sur. No. 229.) Doleryte; Red-rock Bay; runs under the E. Palisades.

16. (Sur. No. 161.) From the hill 520 feet above the lake on N. E. quarter Sec. 25, T. 64, R. 7 E., represents the rocks of the hills about Grand Portage; a doleryte, consisting largely of diallage, plagioclase and magnetite, with chrysolite and a little prehnite.

17. (Sur. No. 275.) From the dyke at the brink of Pigeon river falls; augite, plagioclase, magnetite and chrysolite?

18. (Sur. No. 291.) From the extremity of Pigeon point peninsula; like No. 1; gabbro; plagioclase; diallage, chrysolite, viridite and magnetite.

19. (Sur. No. 297.) Gabbro(?) from the English Rapids, on the international boundary, near Grand Portage; associated with the Animikie Group; augite, plagioclase, magnetite.

20. (Sur. No. 637.) The labradorite rock of Beaver Bay from masses embraced in gabbro.

21. (Sur. No. 664.) Augite, plagioclase, magnetite; from a ridge a little more than two miles north of Horse-shoe Bay.

(b) *Rocks of the Metamorphic Group.*

22. (Sur. No. 1 B.) Brownish-red, hornblende syenite, associated intimately with No. 1. Duluth. Contains orthoclase (changed), quartz, hornblende (often changed), magnetite, apatite and ferrite.

23. (Sur. No. 3.) Brownish or reddish rock. In the Rice Point range of hills; suburbs of Duluth; interception of 5th Av. E. and 7th St.; abruptly separated from No. 1 A by a compact dyke; consists essentially of orthoclase (which makes it sparingly finely porphyritic), quartz and hornblende. It also has apatite, magnetite and ferrite

24 (Sur. No. 7.) Brownish-red rock, fine-grained. Between 2nd and 3rd avenues, Duluth, near the lake. Tabular and imperfect crystals of flesh-red feldspar (orthoclase), viridite (from hornblende), magnetite, apatite, and a small amount of quartz.

25. (Sur. No. 8 A.) Rock inclusion in Survey No. 8; very fine-grained gray rock, showing fine crystals of red feldspar, probably orthoclase, but for the most part this is an amorphous, felsitic mass embracing grains of magnetite and viridite, with other minerals.

26. (Sur. No. 8 B.) Porphyry, Duluth. Has orthoclase, chlorite, magnetite and other minute grains; plainly a rock resulting from the metamorphism of the sedimentary beds.

27. (Sur. No. 8.) Sub crystalline, showing much magnetite and quartz; also undistinguishable grains, some of which are probably viridite, hæmatite and pyrite, in a felsitic paste.

28. (Similar to Sur. No. 8 C.) Finely sub-crystalline, nearly destitute of free quartz, brownish or reddish. Duluth.

29. (Sur. No. 17.) Outwardly and microscopically, a thin-bedded red shale or sandrock; east of the Brewery creek, Duluth, at the lake shore. In thin section

shows a rusty felsitic base with much magnetite or menaccanite, and viridite: the whole clouded with amorphous inclusions.

30. (Sur. No. 33 B) Metamorphic shale. Duluth, at the lake shore; has a felsitic (?) ground-mass, showing a porphyritic orthoclase; magnetite, viridite, hæmatite, apatite, quartz.

31. (Sur. No. 67.) Metamorphic shale, London, near Duluth.

32. (Sur. No. 117.) The reddish vein from Two Harbor rock, Two Harbor Bay. Quartz grains and geodic aggregations, in a reddish orthoclase base.

33. (Sur. No. 124.) Rock of the west bluff, at the entrance to Beaver Bay. Quartz grains with impurities, in a reddish, dimmed base that seems to be orthoclastic, magnetite, apatite.

34. (Sur. No. 127.) Hardened gray shale, from near the mouth of Beaver creek. Quartz grains can be seen in an amorphous, apparently felsitic base.

35. (Sur. No. 129.) Similar to 127, but porphyritic with orthoclase and translucent grains like adularia; a few rods N. E. of the mouth of Beaver creek.

36. (Sur. No. 134.) Quartz, orthoclase, magnetite. The quartz makes up about one-quarter of the whole, the orthoclase perhaps two-thirds, but the magnetite is only in occasional grains. This is from the third island east of Beaver Bay.

37. (Sur. No. 136.) Is from opposite the fifth island east of Beaver Bay. Wholly crystalline red rock, containing quartz, orthoclase and much of a green mineral that is probably changed hornblende. This green mineral is generally fibrous, with spreading, fan-shaped radiations, but not always. Sometimes it shows simply a green felted polarization, always green at +.

38. (Sur. No. 138.) The rock of the Great Palisades; an orthoclastic felsite, porphyritic with adularia, resembling Sur. No. 129.

39. (Sur. No. 201.) Orthoclastic felsite, with a few distinct crystals of orthoclase and adularia or sanidin. This is the Palisade rock from the Copper mine up Fall river.

40. (Sur. No. 264.) From the same place as Sur. No. 263, east of Wauswaugoning Bay. Quartzite fragment embraced in gabbro, quartz and hornblende in a cement of felsite.

41. (Sur. No. 265.) From the upper part of Sur. No. 263, where in contact with the metamorphic rock. Results from the inclusion of a fragment of the sedimentary beds in the igneous. Contains quartz, orthoclase and hornblende, with ferrite and graphite.

42. (Sur. No. 668.) The "red granite" of the region northeast of Grand Marais. Consists of orthoclase, quartz and changed hornblende with magnetite.

(c) *Mixed Igneous and Sedimentary Rocks.*

43. (Sur. No. 1 A.) Gabbro. Duluth. Rice Point range, near a contact with No. 1 B. Contains labradorite, uralitic augite, and titaniferous magnetite. Some of the augite is changed toward viridite Orthoclase in occasional grains.

44 and 45. (Sur. No. 5.) At the depot, Duluth; labradorite, augite, quartz, magnetite, orthoclase, apatite. The augite is sometimes viriditic and sometimes uralitic.

46. (Sur. No. 6.) Labradorite, augite, magnetite, viridite (perhaps a result of change from hornblende) and an occasional grain of quartz. This is a dark-green,

heavy, homogeneous rock, coarsely crystalline, near the bay, in front of the Clark House, Duluth. The igneous type predominates.

47. (Sur. No. 46.) Rock showing the contact between the igneous and the metamorphic groups, from Duluth. One side of the section is red, and contains: quartz in perfectly distinct and abundant grains, making up about one-third or one-half of the whole: orthoclase, which is next in amount to the quartz, these two making up most of the section; apatite in small quantity; magnetite; ferrite and hornblende (?), in a few brownish-green or greenish grains which, on rotation at +, change from bluish-green to yellowish-green, and back again.

The other side is darker, and contains: plagioclase, augite grains (altered to uralite) disposed among the plagioclase, and in larger grains, sometimes fibrous and sometimes broken irregularly; magnetite in much greater amount than in the red rock; ferrite in small quantity.

48. (Sur. No. 263.) Contains the minerals both of the igneous and the sedimentary beds. From the E. side of Wauswaugoning Bay. Its position and limited extent show its accidental occurrence, and merely local importance. The igneous minerals are labradorite and magnetite. The sedimentary are quartz, orthoclase and hornblende. Apatite spicules penetrate them all.

49. (Sur. No. 282.) From the porphyritic main axis of the north part of Susie Island, near Pigeon Point. Contains plagioclase, orthoclase, hornblende, magnetite, quartz, pyrite.

50. (Sur. No. 675.) The rock of the top of Brule′ mountain, north of Grand Marais. Orthoclase, quartz, hornblende, plagioclase (?) magnetite, viridite, ferrite, chrysolite, apatite.

OBSERVATIONS.

The orthoclase of the metamorphic rocks is more readily disseminated through the igneous rocks than the triclinic feldspars of the igneous are through the metamorphic.

The magnetite of the igneous, as at Mayhew Lake, where it forms extensive beds of iron ore, may be derived from the exceedingly ferruginous sedimentary rocks. Magnetite seems to be always present in the crystalline metamorphic, and is probably the result of partial deoxidation from the indigenous hematite that gives them their color. Chemical analysis of the red shales would perhaps show the presence of titanium with the iron before metamorphism, and would indicate the correctness of this hypothesis. Wherever titanic iron is found in Minnesota, it is where the two series of rocks are in contact or proximity, so far as observed.

A fine shale becoming heated and slowly passing toward fusion will first show crystals of the easier fusible minerals, *i. e.*, orthoclase before quartz; and if the change stop there the resulting rock would be a non-differentiated (or felsitic) ground mass sprinkled with porphyritic feldspar crystals, all the siliceons parts being embraced in the ground mass. On the other hand, a fused sedimentary rock, passing to solidification, will first show crystals of the least fusible minerals, *i. e.*, quartz before orthoclase, and hence will contain more or less perfect crystals of quartz, cutting the sides of the later formed orthoclase. Hence the same metamorphic rock may show no quartz in one stage of metamorphism, but an abundance of free quartz in another. If the rock at first held grains of free quartz they would still remain in the former case, and would be an evidence of its original sedimentary source, and in the latter they would of course be subject to recrystallization.

The term felsite, as used in this paper, is intended to express a non-differentiated, somewhat metamorphic rock, derived from shale, without any reference to the origin of felsite rocks described in other places.

V.

THE MUSEUM.

Report for 1881, *and List of Additions.*

During the year, 955 entries have been made in the Museum register. While the most of these specimens have been obtained through the agency of the survey, as in former years, yet many have been received by exchange and by donations. Exchanges have been made with Profs. C. U. Shepherd, Geo. F. Kunz, E. S. Dana, P. H. Mill, Jr., S. Calvin and S. G. Williams. The principal donors have been Col. J. B. Clough, superintendent of the construction of the Northern Pacific Railroad, who has sent the Museum valuable mammalian and archæological specimens from Montana; Mr. W. E. Swan, who has preserved drillings from various deep wells in the State and presented them to the Museum; U. D. Watkins, fossils and other specimens from Ohio; C. E. Whelpley, preserved drillings from the Minneapolis deep well, and Prof. C. W. Hall, various rock specimens from New England. Other donors are Regents Sibley, Chute and Gilfillan, W. D. Hurlbut, J. M. Sullivan, C. M. Terry, H. A. Strong, R. F. Laythe, Prof. J. S. Clark, S. F. Heath, John A. Green, S. Deutsch, D. A. Locke, H. S. Peters and Dr. Miller, Asst. Surgeon U. S. A., Little Missouri Cantonment.

The fossils that have been collected from time to time have not been reported until their names were determined, and hence the most of them are still unreported. They are simply registered and labeled sufficiently to serve for identifying their sources. The crystalline rocks embraced in the series described in the survey report have not yet been registered in the Museum. They have the survey numbers only. Of some of them numerous duplicates have been obtained.

ELEPHANT'S TEETH FROM MONTANA.

Among the donations to the Museum by Col. J. B. Clough is a large elephant's tooth which is worthy of special mention. Its companion, a small specimen, was presented by Mr. S. Deutsch. The two were obtained in the same locality but seem not to have belonged to the same individual. Unfortunately the larger specimen has begun to disintegrate by crumbling, and it is doubtful whether it can be preserved.

These teeth were obtained near the Rosebud river in Montana, by the parties constructing the Northern Pacific R. R , but their special stratigraphical relations to the rocks of the region it has not been possible yet to ascertain. It has been stated by Mr. Deutsch simply that they were from a deep cut composed of clay and loose rock. The adhering portions of the matrix consist of a coarse, lime-cemented sand, or conglomerate like some known to exist in the cretaceous and tertiary, and the tooth is probably not of post-tertiary age.

The larger tooth measures 12¾ inches in length and 6½ inches in transverse perpendicular section. Across the grinding surface it measures a little more than 3½ inches. It has, distinctly preserved, 20 transverse plates. There is an appearance, on the anterior extremity, of a thin, imperfect plate, partly eroded, only a double scale of enamel remaining, separated from the body of the tooth by a little cement. This plate with its cement does not occupy the full width nor depth of the tooth, but was especially pitted to receive the first attrition on the tooth and to maintain its form and position, as the tooth advanced. The posterior end of the tooth also has the appearance of having consisted of one or two more plates originally, but they are now lost by the disintegration which has attacked the whole tooth. Thus the plates must have numbered 22 or 23. The plates existing seem to have all suffered some grinding attrition, but only the anterior sixteen are so worn as to show on the crown the double enamel ridges. The posterior ones, which are more and more inclined forward, the farther they are removed from the front, are either in the immature stage of separate denticles which are not yet united on their summits, or are so involved with the cement that they are not yet even worn so as to produce the annular ridge of enamel exhibited by those farther advanced. The bases of these plates, however, with denticles at their summits, are united together into a common complex fold, firmly binding the tooth in one mass. This therefore seems to have been the sixth or last, molar of a mature elephant, or mammoth, and from the lower jaw.

The smaller tooth has lost by disintegration and fracture apparently about four of its plates from its posterior extremity. While it was found in the same locality it was probably not from the same individual. Its crown appears to have been unequally opposed by the tooth of the other jaw, for its plates are not worn off so as to show continuous transverse ridges of enamel, except on the anterior portion, the greater number of plates being simply rounded over, the denticles standing above the surface with their natural curved contour, with no flattened, grinding sarface. From the fact that the denticles are somewhat worn they must have served for mastication. The smooth, flattened, and oppressed appearance of the anterior extremity indicates that the preceding tooth had not yet been shed, but had been thrust by mastication constantly against it. Still it was not wholly protected by its predecessor, but was exposed *on the end*, as well as on the grinding surface to the attrition of mastication, and its most advanced corner is worn off obliquely by that means. It had about fourteen plates and its length was about ten inches. It was probably the fifth upper molar of the extinct mammoth.

The region in which the teeth were found is not drift-covered, but the soil and surface debris is the result of local disintegration of the cretaceous or tertiary beds. It is hence very probable that these teeth are true fossils, of an age prior to the glacial epoch.

SPECIMENS REGISTERED IN THE MUSEUM IN 1881.

Serial Numbers.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3736	Aug., 1880	C. W. Hall.	Granite	2	Rockport, Mass		C. W. Hall, Rockport Granite
3737	"	"	Granite	2	Quincy Mass		" Quincy Granite
3738	"	"	Petrosilex	4	Marblehead Neck, Mass	Huronian	" Porphyritic
3739	"	"	Diorite	2	" "	"	"
3740	"	"	Diorite	1	" "	"	"
3741	"	"	Petrosilex	2	" "	"	" Finely Crystalline, weathering surface shows effect of pressure on the bedding
3742	"	"	Granite	2	Manchester, Mass	Montalban	C. W. Hall, considerably weathered
3743	"	"	Serpentine	1	Lynn, Mass		"
3744	"	"	Breccia	2	Marblehead Neck, Mass	Shawmeet	" Petrosilicious
3745	"	"	Breccia	6	" "	"	" Water-worn and weath'd
3746	"	"	Dialase	2	Salem Harbor Baker' Slam	Naugus H'd Series	" Showing vein of Elvanite
3747	"	"	Feldspar	1	" "	"	" Pyroxenic
3748	"	"	Beach pebbles of Petrosilex	5	Marblehead Neck, Mass	Huronian	" Showing bedded structure
3749	"	"	Beach pebbles of Petrosilex	10	" "	"	" " Porphyritic
3750	"	"	Beach pebbles of Diorite	4	" "	"	"
3751	"	"	Slag from iron furnace	2	Detroit, Mich		" Form'd in smelt'g sc'p iron
3752	Oct., 1880	"	Haematite	1	Kewanaw, Vt	Huronian	C. W. Hall, Micaceous and folded by pressure
3753	"	"	Limestone, Glen's Table Block Marble	1	Glen's Falls, N. Y	Trenton	Presented by J. M. Sullivan
3754	"	"	Sandstone	2	Opp Fond du Lac	Potsdam	Used in const'n of Westminister C'h.
3755	Nov., 1880	Geol. Survey	Sandstone	1	Taylor's Falls	St Croix	C M. Terry, show'g lines of iron stain
3756	"	C. M. Terry	Shell Limestone	2	St. Agustine, Fla	Tertiary	Presented by C. M. Terry
3757	Dec., 1880	Geo. Nat. Hist. Sur.	Galenite, (weight 390 lbs.)	1	Galena, Ill	Galena	Purchased by Regent Chute
3758	Nov., 1880	C. U. Shepard	Meteoric Iron found in 1865	1	Bonanza. N. Mexico		By exchange with Prof. C. U. Shepard
3759	"	"	Meteoric Stone, Jan. 30, 1868	1	Poltusk Vasovia, Poland		" "
3760	"	"	Meteoric Stone, Jan. 9, 1866	1	Knyahinya, Hungary		" "
3761	"	"	Meteoric Stone, Feb. 25, 1847	1	Linn Co. Iowa		" "
3762	"	Alf'd R. C. Selwyn	Meteoric Stone, found in 1872	1	Mitchell Co., Kansas		" "
3763	"	Geol & Nat Hist Sur	Eozoon Canadense	3	Petite Nation, Can	[Lan.	Presented by the Geol. Sur. of Canada
3764	Dec., 1880	"	Cubic Galenite, (slab on carb. zinc)	1	Galena, Ill	Galena	Purchased by Regent Chute
3765	"	"	Cubic Galenite	6	"	"	" "

Specimens Registered in the Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3766	Dec., 1880	Geol & Nat Hist Sur	Sphalerite	1	Galena, Ill	Galena	Purchased by Regent Chute
3767	"	"	Pyrite	4	"	"	" "
3768	"	"	Ores from Galena	3	"	"	" "
3769	"	"	Pyrite, (cylindrical stems)	4	"	"	" "
3770	1880	"	Brick	1	Marshall		Warren Upham, (W. A. Crooker, Maker)
3771	"	"	Brick	1	Jackson		Warren Upham, (Maj. H. F. Bailey)
3772	"	"	Brick	1	Marshall		Same, (James M. Lockey)
3773	"	"	Granite	6	Near W line sec 29, Posen, Y. Med. Co.		"
3774	"	"	Granite	21	1½ m S E from Big Stone Lake		"
3775	"	"	Granite (?)		Redwood Falls		" (Quarried)
3776	"	"	Gneiss	25	2 m S E from Montevideo		"
3777	"	"	Gneiss	21	Granite Falls		" Excavated in Main street)
3778	"	"	Cretaceous Sandstone	20	Sec. 12, Altavista, Lincoln Co.	Cret	"
3779	"	"	Granite	3	N E ¼ sec 34, Echo, Y. Med. Co.		" Nearly all this outc'p is Gneiss
3780	"	"	Hornblendic Schist	3	Sec 17, Omro, Y. Med, Co., (N W outcrop)		"
3781	"	"	Hornblendic Schist	8	" (S E outcrop)		"
3782	"	"	Cemented Drift Gravel	3	S W ¼ sec 31, Nordland, Lyon Co		"
3783	"	"	Pottery Clay	3	N part sec 3, Sigel, Brown Co.	Cret	"
3784	"	"	Protogine Gneiss	3	West side Redwood river,		" Opp. Birum's mill.
3785	"	"	Cretaceous Sandstone (?) weathered)	2	N E ¼ sec 20, Eidsvold, Lyon Co	Cret	" On land of Henry Jacobs,
3786	"	"	" " (fresh)	3	" "	"	"
3787	"	"	Red Quartzyte		N E ¼ sec 25, Selma, Cot. Co	Potsdam	"
3788	"	"	Potsdam Sandstone, (Quartzyte range)		N E cor. sec 36, Germantown, Cot. Co	"	" At Mound Creek Falls
3789	"	"	Red Quartzyte		W p't S W ¼ sec 6, Dale, Cot. Co	"	"
3790	"	"	Red "		" "	"	" Containing breccia fragments of Pipestone
3791	"	"	Lignitic Sandstone	4	S E ¼ sec 2, Eidsvold, Lyon Co	Cret	" "Petrified tree."
3792	"	"	Clay containing Cretaceous shells	1	Sec 8, T 111, R 38, Redwood Co		" (Absalom Ames' well)
3793	"	"	Gneiss	1	N E ¼ sec 12, T 111, R 38, "		"

3794	1880	Geol & Nat Hist Sur	Pipestone enclosed in Quartzyte	2	S W ¼ sec 2, Amboy, Cot. Co	Potsdam	“	(Much jointed)
3795	“	“	Red Quartzyte	2	S E ¼ sec 23, Selma, Cot. Co	“	“	
3796	“	“	Red “	2	S W ¼ sec 18, Delton, “	“	“	
3797	“	“	Pipestone in Quartzyte	5	W p't S W ¼ sec 6, Dale, Cot. Co	“	“	Peter Schmidt's quarry
3798	“	“	Potsdam Quartzyte	2	N p't sec 31, Stately, Brown Co	“	“	Falls in E branch of Mound Cr
3799	“	“	Sandstone (Oolitic in structure)	1	N W ¼ sec 7, Eidsvold, Lyon Co	Cret	“	
3800	“	“	Lignitic Cretaceous Sandstone	1	N W ¼ sec 3, Sigel, Brown Co	“	“	Overlying pottery clay (No 3783)
3801	“	“	Gneiss (weathered)	1	N E ¼ sec 12, T 111, R 38, Redwood Co		“	
3802	“	“	Cretaceous Sandstone	2	Sec 7, Westerheim, Lyon Co		“	
3803	“	“	Potsdam Quartzyte	2	N E cor. sec 36, Germantown, Cot. Co		“	At Mound Creek Falls
3804	“	“	Cretaceous Sandstone	2	Sec 12, Altavista, Lincoln Co		“	
3805	“	“	Bones and Petrified Wood	4	Shore of Swan Lake, N W Cor Redwood Co	Drift	“	Pres. by Malcolm McNiven
3806	“	“	Lepidodendron	1	Lake Okabena, Worthington	“	“	Pres. by J. A. Phelps
3807	“	“	Quartzyte	3	Mound, Rock Co		“	J. F. Shoemaker's Quarry
3808	“	“	Cretaceous Sandstone, with leaf impressions	1	N side Cottonwood river, sec 25, North Star		“	Pres. by John F. Burns
3809	“	“	Cretaceous Sandstone, (fossiliferous)	1	“ “		“	“ “
3810	“	“	Brick	1	Brainerd		“	(Mr. Schwartz, maker)
3811	“	“	Sandstone	27	Hinckley, Pine Co	Potsdam	“	
3812	“	“	Trap	4	Watab, Benton Co		“	Forming S E side of T. N. Newson's shaft
3813	“	“	Syenite	2	“ “		“	Talcott, Castle & Co
3814	“	“	Syenite	2	“ “		“	land of Jos. Campbell
3815	“	“	Trap		Chengwatana, Pine Co		“	
3816	“	“	Syenite, (very dark)	2	N W ¼ sec 33, St. Cloud		“	
3817	“	“	Syenite	3	N. E. ¼, sec 32, St. Cloud		“	
3818	“	“	Syenite	2	S W ¼ sec 17, Haven, 4 m S E of St. Cloud		“	Robbers & Barthelemy's quarry
3819	“	“	Red Syenite	3	Haven, 2 m S E of St. Cloud		“	Breen & Young's quarry
3820	“	“	Gray Syenite	4	“ “		“	
3821	“	“	Gray Syenite	3	Sauk Rapids		“	Collins, Mitchell, and Searle
3822	“	“	Staurolitic Schist	2	3 m s of Pike Rpds in E bnk Miss		“	I. P. Lambert's land
3823	“	“	Syenite	2	Sec. 26, St. Joseph, Stearns Co		“	Fred Schilplin's land
3824	“	“	Syenite	1	2 mi. W. of Cold Spring		“	
3825	“	“	Syenite	1	Cold Spring, Stearns Co		“	
3826	“	“	Vein and Reddish Syenite	1	Sec. 27, Watab, Benton Co		“	T. N. Newson's shaft
3827	“	“	Syenite (coarse grained)	2	Sec. 19, St. Augusta, Stearns Co		“	
3828	“	“	Syenite	1	N W ¼ sec 17, St. Cloud		“	
3829	“	“	Syenite (dark)	1	Sec. 27, Watab, Benton Co		“	Hill 1-6 m E. of Newson's shaft
3830	“	“	Syenite (reddish)	1	Sec. 35, Watab, Benton Co		“	H. D. Gurney's quarry
3831	“	“	Syenite (red)	1	Le Sauk, Stearns Co		“	½ m N. of Sartell's grist-mill
3832	“	“	Granite (coarse)	2	Rockville, Stearns Co		“	only rock at Rockville
3833	“	“	Syenite (dark)	1	Sec. 27, Watab, Benton Co		“	N W side of hills near Miss
3834	“	“	Syenite (grey)	1	Sec. 35, Watab, Benton Co		“	H. D. Gurney's quarry
3835	“	“	Syenite (dark)	2	2 m s e of Richmond, Stearns Co		“	
3836	“	“	Syenite (reddish, fine grained)	1	Cold Spring, Stearns Co		“	
3837	“	“	Syenite or Granite	1	East p't sec 18, St. Cloud		“	
3838	“	“	Porphyry	1	Sec. 19, St. Cloud		“	(locality not visited)

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3839	1880	Geol & Nat Hist Sur	Rock somewhat used for railroad masonry.....	2	Quarried near Thompson or Duluth..................	....	" (from Brainerd car-shops).....
3840	"	"	Syenite....................................	1	Sec. 21, Le Sanx, Stearns Co...	....	" at Sartell's grist-mill..........
3841	"	"	Syenite (dark)..............................	1	S W cor sec 28, St Cloud.......	....	" (In road.).....................
3842	"	"	Syenite (porphyritic, reddish)...............	1	Sec. 27, Watab, Benton Co.	....	" w side of vein T N Newson's shft
3843	"	"	Agates.....................................	1	Royalton, Morrison Co.........	Drift.	" presented by Harry Young.....
3844	"	"	Vein.......................................	1	Sec. 27, Watab, Benton Co......	....	" T. N. Newsons shaft...........
3847	"	"	Kaolin.....................................	1	Mouth of Two Rivers, Mor'n Co	Cret.	" Calvin A. Tuttles well..........
3848	"	"	Garnetiferous Schist........................	....	2 m. below Pike Rapids........	....	Warren Upham, W. side of Miss. R...
3849	"	"	Pebbles from Sandstone......................	....	Knife R. bridge on Snake R.....	Potsdam.	" 6 m N. of Bruns'ck, Kan'c Co.
3850	"	"	Sandstone..................................	6	Knife R. bridge on Snake R.....	Potsdam.	" ....
3851	"	"	"	8	7 m. E. N. E. of Rush City, ½ m. above mouth of Rock Creek	St. Croix.	" Minn. side of St. Croix River.
3852	"	"	"	2	" "	"	" Wis " " "
3853	"	"	" containing large pebbles........	1	" "	"	" " " "
3854	"	"	Red Shale used for paint....	1	St Croix R bet Snake & Kettle R's	"	" a layer in sands'ne on Wis side
3855	"	"	Fossiliferous Shale.........................	5	30 rds. above Taylor's Falls Bg.	"	" West bank St Croix River.
3856	"	"	" "	5	Taylor's Falls..................	"	" ....
3857	"	"	Trap.......................................	1	" "	....	" near N. C. D. Taylor's shaft..
3858	"	"	"	2	" "	....	" ....
3859	"	"	"	1	" "	....	" at Landing...... ....
3860	"	"	"	1	1 m. S. W. Taylor's Falls.....	....	" under the conglomerate.......
3861	"	"	"	1	" " "	....	" over " " ....
3862	"	"	Cuprif. Conglomerate in trap rock............	1	" " "	....	" Dip. 12° W S W bed, 8 ft thick
3863	"	"	Vein-matter................................	4	" " "	....	" Taylor's Falls, Mining Co.....
3864	"	"	Ore (Arseno-pyrite?)........................	1	" " "	....	" found in Trap................
3865	"	"	Native Copper..............................	1	" " "	....	" Taylor's Falls Mining Co.....
3866	"	"	Ore (Ruby blende?)..........................	1	" " "	....	" bet shafts of N. C. D. Taylor & T. F. Mining Co..............
3867	"	"	Sandstone, fossiliferous.....................	2	Franconia ¼-½ m north of Munch's mill, St. Croix......	St. Croix.	W Uph'm, in ravine of Lawr'nce Creek
3868	"	"	" "	1	At Munch's mill, Franconia ...	"	" (Mill is built of this)..........
3869	"	"	Shale......................................	2	" "	"	" ....

3870	1880	Geol & Nat Hist Sur	Sandstone, fossiliferous	10	Franconia, Chisago Co	St. Croix.	W. Upham
3871	"	"	Calcareous Tufa	4	" 1-5 m. S of Munch's Mill	....	" used for lime, very large dep't.
3872	"	"	Gneiss (weathered)	1	N E ¼ Sec 32 Echo Yel Med Co.	....	" ....
3873	"	"	Granite (coarse, reddish, feldspathic)	1	" " " "	....	" at S. end of Gneiss
3874	"	"	Mica Schist (black) in Gneiss	1	" " " "	....	" ....
3875	"	"	Gneiss	1	N E ¼ sec 12; T 111, R 38, Redwood Co	....	" ....
3876	"	"	Mica Schist (dark) in Gneiss	1	N E ¼ sec 12, T 111, R 38, Redwood Co.	....	" in two or three masses, each 2or 3 feet long
3877	"	"	Gneiss	1	Redwood Falls	....	Warren Upham, Main Falls
3878	"	"	Trap dike	1	" "	....	" "
3879	"	"	Hornblende Schist	1	East Granite Falls	....	" bet bridge and Pillsb'y's El'or.
3880	"	"	" (jointed, traplike)	1	" "	....	" at Pillsbury's elevator
3881	"	"	Red Quartzyte	1	N W ¼ sec 29, Adrian, Wat. Co.	Potsdam.	" ....
3882	"	"	" "	1	S E ¼ sec 30, Delton Cot. Co.	"	" ....
3883	"	"	" "	1	N W ¼ s 28, Storden Cot. Co	"	" ....
3884	"	"	Specimens of stone	....	R. R. well at Heron Lake	"	" the red pieces from 180-220 ft., the yellow lower, 1 ft. thick
3885	"	"	" "	....	" " "	"	W Uph'm, drilled thro. in 1st 180-220 ft.
3886	"	"	Red Quartzyte	2	Pipestone City	"	" quarried by Chas H Bennett
3887	"	"	Red Quartzyte (ripple marked)	2	" "	"	" "
3888	"	"	Conglomerate	1	4 m. S. W. from Pipestone City.	"	....
3889	"	"	Red Quartzyte	2	Dell Rapids, Dak., 18 m. N. of Sioux Falls	"	" ....
3890	"	"	" "	2	Sioux Falls, Dak	"	" ....
3891	"	"	" "	1	Devils Gulch, Minnehaha Co. Dak. 2½ m. N. E. of Palisades	"	" ....
3892	"	"	Pipestone	1	Palisades, Minnehaha Co., Dak.	"	" stratum. 5 ft. thick, 5 rods S. of dam and 10 feet below
3893	"	"	" (mottled variety)	1	" " "	"	W. Upham, " " "
3891	"	"	"	1	" " "	"	" ¼ m. S. W. of mill, 7 ft. thick.
3895	"	"	Sandstone (pink)	2	" " "	"	" half way in location and appearance, between pipestone and "chalk rock", all being in s. plane.
3896	"	"	" (white)	4	" " "	"	W Up'm, "chalk rock", 20 rds. E of dam, and in plane with pipestone.
3897	"	"	" (white) a var. holding concretions	2	" " "	"	W Up'm, "chalk rock" grad ch to this
3898	"	"	" (pink)	1	" " "	"	" lower pt of bed of "ch'lk r'ck"
3899	"	"	St. Lawrence Limestone	1	Judson, Blue Earth Co	Lr. Mg.	" Mrs G W Wolf's qu'y at house
3900	"	"	" " " (arenaceous)	1	" "	"	" q ½ m S E of hs; lower pt of bs
3901	"	"	" " " "	1	" "	"	" ½ m W of Mrs G W Wolf's hs; lower part of beds
3902	"	"	" " " "	1	" "	"	W. Upham, C. G. Swanson's quarry
3903	"	"	Jordan Sandstone	1	Near center of N W ¼ sec 12 Jud.	Jordan.	" brink of unnamed water fall.
3904	"	"	" "	1	Minneopa Falls, Blue Earth Co.	"	" ....
3905	"	"	" "	1	N. W. ¼ sec. 17, South Bend, Blue Earth Co.	"	" ....
3906	"	"	Shakopee Limestone	1	South Bend, Blue Earth Co.	Shakopee.	" David P Davis' quarry
3907	"	"	" "	2	L B'nk, Wat. R, N E of G'dn C'y	"	" qy. on S M Folsom's estate.
3908	"	"	" "	1	W. side Maple R., S W ¼, sec. 12; Rapidan B. E. Co.	"	" Columbus Ballard's quarry.

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3909	1880	Geol & Nat Hist Sur	Sandstone containing lignite-particles	1	Sec. 6 Rutland, Martin Co.	Cretaceous.	" G S Livermore's land, sometimes oolitic, like the Altavista stone which perhaps corresp'ds with this.
3910	"	"	Sandstone	2	" " S side Elm Creek	"	Warren Upham, G S Livermore's land.
3011	"	"	Willow leaf in sandstone (A)	2	Sec 25, North Star, Brown Co.	"	same, N. bank of Cottonwood River.
3912	"	"	" " " (B)	1	" " " "	"	" " " "
3913	"	"	Clay	1	R R well at Wal't Grove, Red Co	"(?)	" 60- 80 feet
3915	"	"	Iron Pyrites	1	P. Crampton's well, S W ¼ sec 8, Eidsvold Lyon Co	"	"
3920	"	"	Gypsum	1	Sec. 28, Grand View, Lyon Co.	"	" S. W. Lathe's well
3921	"	"	Clay in hollows of Shakopee Limestone	1	South Bend, Blue Earth Co.	"	"
3922	"	"	Clay	1	Red Jacket Mills, Blue Earth Co	"	" used by A Gapter at Mankato for pottery
3923	"	"	Gravelly Clay	1	" " "	"	" thin layer in sand at base of Gapter's clay bank
3924	"	"	"Chalk"	1	" " "	"	" Gapter's clay-bank
3925	"	"	Limestone	1	White Earth Agency	Drift.	" boulders and gravel, common.
3926	"	"	Specimen of the "Three Maidens"	1	Pipestone Quarry, Pipestone Co.	"	" originally one gigantic boulder.
3927	"	"	Calcareous Tufa	....	Camden Mill, Lynd, Lyon Co.	....	"
3928	"	"	Septaria	1	Jackson, Jackson Co	Drift	" from a cellar, pres. by G. C. Chamberlin
3929	"	"	Septaria-like stone	1	Sec. 6 Rutland, Martin Co.	"	"
3930	"	"	Drift gravel, cemented by calc. tufa	1	Garden City, Blue Earth Co., 20-30 rds E of E T Nort'n's hs	"	" S E side Wat. River
3931	"	"	Iron-cemented gravel	1	Red Jacket Mills, Blue Earth Co	"	" above pottery clay (3922)
3932	"	"	Petrified wood	....	" " "	"	" found by Georgie S. Bingham
3933	"	"	Wood, S. C. Gale's well	....	Sec. 10, Gales, Redwood Co.	"	" at 27 feet, below blue till
3934	"	"	Hollowed pebbles	....	" " "	"	" presented by S.C. Gale
3935	"	"	Hollowed pebbles	1	S. W. Minnesota		
3936	"	"	Efflorescence	....	Sec 14, Iona, Murray Co	"	"
3937	"	"	(Scale)	1	Marshall, Lyon Co.	....	" from thresher boiler used 3 mos
3938	"	Geo. F. Kunz.	Vertebra	1	Charleston, S. C.	Cretaceous.	By exchange
3939	"	"	Chlorophane	1	Hardin Co., Ill	....	"

3940	1880	Geo. F. Kunz.	Celestite and Sulphur	1	Mt. Girgenti, Sicily	Cretaceous.	By Exchange	
3941	"	"	Sphalerite and Marcasite	2	Missouri		"	
3942	"	"	Calcite, (Dog tooth Spar)	1	Falls of Ohio, Louisvile, Ky		"	
3943	"	"	Silver on Galena and Sphalerite	1	Silver City, Ark		"	Demby mine
3944	"	"	Natrolite	1	Aussig, Bohemia		"	
3945	"	"	Gold and Silver	1	Silver City, Ark		"	Diamond Joe mine
3946	"	"	Whalebone	1			"	
3947	"	"	Aragoanite. "Sprudelstein"	1	Karlsbad, Bohemia		"	
3948	"	"	Gold and Silver	4	Silver City, Ark		"	
3949	"	"	" " in slate	1	" "		"	Diamond Joe mine
3950	"	"	Aphorite	1	Lime Rock, R. I		"	
3951	"	"	Wavellite, (white variety)	1	Bohemia		"	
3952	"	"	"	1			"	
3953	"	"	Ottrelite	1	Ottrez. Belgim		"	
3954	"	"	Magnetite	1	Port Morris, N. Y		"	
3955	"	"	(?)	2	England		"	
3956	"	"	Monazite	1	Koralfet, Sweden		"	
3957	"	"	Elaeolite—sunstone—	1	Magnet Cove, Ark		"	
3958	"	"	Fascicolite	1	Vermont		"	
3959	"	"	Phyllite	1	Chauston, R. I		"	
3960	"	"	Bituminous Coal	Indf	Mahoning Co., Ohio		"	
3961	"	"	Pseudovermiculite	2	Magnet Cove, Ark		"	
3962	"	"	Ore from Iron mine	2	Monroe, N. Y		"	
3963	"	"	Pyrite and Hematite	1	Rossie, N. Y		"	
3964	"	"	Vasite	1	Ytterby, Sweden		"	
3965	"	"	Rosettes of Nigrine	6	Magnet Cove, Ark		"	
3966	"	"	Fluorite	2	Hardin Co., Ill		"	
3967	"	"	Brookite on rock	1	Magnet Cove, Ark		"	
3968	"	"	Hydrolitanite	3	" " "		"	
3969	"	"	Perofskite	Indf	" " "		"	
3970	"	"	Schorlomite	1	" " "		"	
3971	"	"	Nacrite on Calcite	1	Lime rock, R. I.		"	
3972	"	"	Bowenite	1	Cumberland, R I.		"	
3973	"	"	Gehlenite	1	Austria		"	
3974	"	"	Kjerulfin and Tschernakite	1	Norway		"	
3975	"	"	Ludwigite	1	Westphalia		"	
3976	"	"	Erbenstein	1	Karlsbad, Bohemia		"	
3977	"	"	Hornblende in quartz	1	Cumberland, R. I.		"	
3978	"	"	Quartz geode	1	Brazil		"	
3979	"	"	Smoky quartz	1	Minas Geras, Brazil		"	
3980	"	"	Glauconite	2	Marlboro, Monmouth Co., N. Y		"	
3981	"	"	Piece of shark's rib	1	Charleston, S. C		"	
3982	"	"	Conglemerate	1	Pennsylvania		"	oil layer
3983	"	"	Pearl Spar	1	Niagara Falls, N. Y		"	
3984	"	"	Calcite, (hexagonal)	1	St. Anthony's Nose, N. Y		"	
3985	"	"	Calcite (dog-tooth spar) and dolomite	1	Lockport. N. Y		"	
3986	"	"	" "	1	Niagara Falls, N. Y		"	
3987	"	"	Petragotus sp?	1	Buffalo, N. Y		"	
3988	"	"	Calc tufa, replacing sticks	1	New York		"	
3989	"	"	Coral	4	Falls of Ohio, Louisville		"	
3990	"	Geol & Nat Hist Sur	Shakopee limestone	3	St. Peter, Nicollet Co	Shakopee.	Warren Upham,	Jno. Malgrien's quar'y

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3991	1880	Geol & Nat Hist Sur	Shakopee Limestone, (weathered)............	1	St. Peter, Nicollet Co.........	Shakopee.	Warren Upham, A. J. Lamberton's quarry, worked by Hugh Brogan.
3992	‘‘	‘‘	‘‘	1	Eagle Creek, 4 m E of Shakopee	‘‘	Warren Upham, Thos. Durose's land.
3933	‘‘	‘‘	‘‘	2	Mankato......................	‘‘	‘‘ George Maxfield's quarry, the three foot shaly cement layer.....................
3994	‘‘	‘‘	‘‘	1	“	‘‘	‘‘ Geo. Maxfield's best cut stone 4 feet thick, next below the shaly layer..................
3995	‘‘	‘‘	‘‘	1	“	‘‘	‘‘ Geo. Maxfield's quarry, cut stone at 6 feet above shaly layer.....................
3996	‘‘	‘‘	‘‘	1	“	‘‘	‘‘ Geo. Maxfield's, 12 or 15 feet above shaly layer; red layer of cut stone 3 feet thick....
3997	‘‘	‘‘	‘‘	3	Lime S E ¼ sec 19, Blue Earth Co	‘‘	‘‘ Joseph Kunz's quarry..........
3999	‘‘	‘‘	‘‘	1	Mankato	‘‘	‘‘ J. R. Beatty—the quarry on road to Red Jacket mill, said to yield good hydr. cement
4000	‘‘	‘‘	‘‘	3	Lime sec 20, Blue Earth Co.....	‘‘	‘‘ J. R. Beatty..................
4001	‘‘	‘‘	‘‘ (iron-stained)..................	1	1–5 m s of Sioux City, Merriam Junction, Scott Co...........	‘‘	‘‘ In railroad cut................
4002	‘‘	‘‘	‘‘	1	Sec. 18, Decoria, Blue Earth Co	‘‘	‘‘ Mait Ryan's quarry............
4003	‘‘	‘‘	Jordan sandstone..........................	2	Jordan, Scott Co	Jordan.	‘‘ Frank Nicolin's quarry........
4004	‘‘	‘‘	‘‘	3	“ “	‘‘	‘‘ Foss, Wells & Co's. quarry....
4005	‘‘	‘‘	Trenton limestone...........................	3	Sec. 27, Eureka, Dak. Co.......	Trenton.	‘ Amund Torgerson's quarry.....
40 6	‘‘	‘‘	Boulder containing a green mineral............	3	Blooming Grove, Waseca Co....	Drift.	‘‘ ....
4007	‘‘	‘‘	Pebbles and Boulders...........................	Indf	Sec. 13, Kiester, Farib. Co......	‘‘	‘‘ from top of Kiester hills & kames
4008	‘‘	‘‘	Round pebbles from hollows in Shak. limestone	....	Sec 19, Lime, Blue Earth Co....	....	‘‘ At J. Kunz' quarry, probably preglacial river gravel.....
4009	‘‘	‘‘	Boulder (15 ft. in diameter)....................	1	1½ m. E. of Shakopee..........	Drift.	‘‘ ....
4010	‘‘	‘‘	Black, fetid mud............................	1	Freeborn, Freeborn Co..........	‘‘	‘‘ 1 foot thick in well at 96 feet...
4011	‘‘	‘‘	Upper Till..................................	1	“ “	‘‘	‘‘ coal boring, 1880.... ....
4012	‘‘	‘‘	Dark, very hard Till.	1	Verona Star Mills.............	‘‘	‘‘ Alex Halliday. ....

4013	1880	Geol & Nat Hist Sur	Dark, very hard Till, sandy portion of	1	Verona Star Mills	Drift.	Warren Upham, Alex Haliday
4014	"	"	Yellow Till	1	" "	"	Same "
4015	"	"	Brick, cream-colored	2	Mankota, Minn.		" Mankato Brick Co.
4016	"	"	Brick, red	1	" "		" " "
4017	"	"	"	1	" "		" F. Polchow & Co.
4018	"	"	"	1	" "		" Williams & Grothe
4019	"	"	"	1	Sec 8, McPherson, B. E. Co		" Gokler Bros
4020	"	"	"	1	Sec. 11, Verona, B. E. Co		" Westbrook & Ferguson
4021	"	"	"	1	Albert Lea		" Rusfoldt & Kleven,
4022	"	"	Lignite	3	Little Missouri R. Dak		N. H. Winchell
4023	"	"	Silicified wood	2	" "		Same
4024	"	"	"	1	" "		Presented by Capt. Wolfalk,
4025	"	"	Concretions of (?)	2	" "		N. H. Winchell
4026	"	"	Slags	3	" "		Same { Produced by burning of lignite beds
4027	"	"	Indurated clay, (red)	8	" "		" " " "
4028	"	"	" (banded)	3	" "		" " " "
4029	"	"	Limestone	15	Lanesboro	St Lawrence	"
4075	"	"	"	17	Near Spring Valley	Trenton.	" Weisbach's Dam
4089	"	"	" slab	1	Spring Valley	Galena.	"
4096	"	"	Silicious buhr-stone	1	Bennington, Mower Co	Drift.	"
4099	"	"	Limestone	13	Lime City	Galena.	"
4108	"	"	Lead ore, (on the St. Lawrence Limestone)	3	Dresbach, Minn	St. Croix.	" Winona Co. Mining Co
4109	"	"	Green sand	3	"	"	" " "
4110	"	"	Flag and sandstone, (lingula bearing)	12	"	"	" " "
4111	"	"	Iron septaria	2	"		" " "
4112	"	"	Freestone	1	"	St. Croix.	" " "
4114	"	"	Brick	1	Sec. 34, Manomin		Warren Upham, Peterson & Benson.
4115	"	"	Mineral Paint	1	Redwood Falls.		" Manufactured 1869.
4116	1881	H. A. Strong.	Limestone	1	Decorah, Iowa	Trenton.	{ Pres. by H. A. Strong, Decorah, "Fossil Marble"
4117	"	Edw. S. Dana.	Danburite, Crystal groups	3	Russel, St. Lawrence Co., N. Y.		By exchange with Yale College
4118	"	"	" detached crystals	2	" "		Same
4119	"	"	"Pallas Iron," meteoric	1	Krasnojarsh, Siberia		" Date of discovery, 1876
4120	"	"	Meteoric Iron	1	Augusta Co., Va.		" Date of discovery 1858-59
4121	"	"	" stone	1	Sleele-Nowy, Poland		" Date of fall Jan 30, 1868
4122	"	"	" "	1	Weston, Conn		" Date of fall, Dec. 14, 1867
4123	"	"	" iron	1	Sylanieza, Hungary		" Date of discovery, 1844
4124	"	"	" stone	1	Parnallee, India, (Hindostan)		" Date of fall, Feb. 28, 1857
4125	"	C. W. Hall.	" iron, showing Widmanstathian figures	1	Estherville, Emmet Co., Iowa		Presented: date of fall, May 10, 1879
4126	"	G. H. Dike.	Ammonites sp. (?), part of a cast	1	Foot hills, Black Hills		" by Mr. Dike
4128	May, 1879	By Purchase.	Peckhamite	Sev.	Estherville, Iowa		{ The new mineral found in the Estherville meteorite and named by Dr. J. L. Smith after Prof. S. Peckham. (See Am. J. Aug. 1880)
4129	Oct., 1880	J. S. Clark.	Hematite	1	East River mines, N. S.		Presented by Prof. Clark
4130	"	"	Fossil plants	Sev.	{ Stil arton coal mines, Pictou Co. N. S.	Carbonifer's	Same { characteristic plants from the N. S. coal
4131	July, 1880	Geol & Nat Hist Sur	Sandstone	3	Taylor's Falls		C. M. Perry, (south of the "dike")
4132	"	"	Orthoceras, section	1	Shore of Star Lake, O. T. Co.	Drift.	Same
4133	"	"	Blue clay	1	Evansville	"	" (50 feet below surface)

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4134	July, 1880	Geol & Nat Hist Sur	Part of pebble	1	Fergus Falls	Drift.	C.M.Ferry, (from clay of Fergus Falls)
4135	"	"	Clay	1	Spirit Knob, L. Minnetonka	"	"
4136	"	"	Decayed stone and concretions		Evansville	"	" (clay banks)
4137	"	"	Fine clay		Mouth of Turtle R. Polk Co.	"	A. P. Hendrickson
4138	"	N. C D. Taylor.	Copper ores, etc	Indf	Taylor's Falls		N. C. D. Taylor
4139	"	Geol & Nat Hist Sur	Clay	1	Bed of Miss., T. 145, N. R. 35 W		O. E. Garrison, beneath the river deposits, on flood plain [95]
4140	"	"	Red Quartzite or Sandstone, (conglomerated)	1	Pokegama Falls	Potsdam.	O. E. Garrison, (Upper strata where the arrow like fall begins), [96]
4141	"	"	" "	1	" "	"	O. E. Garrison, (Upper strata, a little below the apron, 10 feet above water ledge), [97]
4142	"	"	Reddish sandrock	1	" "	"	O. E. Garrison, (Lowest strata visible in the perpendicular walls), [98]
4143	"	"	Coarse sandstone	1	" "	"	O. E Garrison, (Lowest strata visible in the perpendicular walls), [98a]
4144	"	"	Rotted sandstone	1	" "	"	O. E. Garrison, (From apron, flooded in high water(, [99]
4145	"	"	Clay	1	Lower landing, Pokegama Falls		O. E. Garrison, (From gully on bluff). [101]
4146	"	"	Coarse Quartzyte	1	Lower falls Prairie R. sec. 34, T. 56, R. 26	"	O. E. Garrison, (In river bed, covered in high water; cracked in all directions), [102]
4147	"	"	Gray and pinkish quartzyte	1	Lower falls Prairie R., sec. 34, T. 56, R. 26	"	O. E. Garrison, [103], (Near [102], but not flooded
4148	"	"	Red quartzyte	1	Prairie River Falls	"	O. E. Garrison, [104], (Highest point of exposure, and west of the trail from lower landing to lower lake.
4149	"	"	"	1	" "	"	O. E. Garrison, [105], (From a loose scale, but on exposure same as 104.)

4150	July, 1880	Geol & Nat Hist Sur	Red Quartzyte		Prairie R. Falls, sec. 33. T. 56, N. R. 25 W	Potsdam.	O. E. Garrison, [106], (Near the middle of the exposure, near the trail around the upper falls)
4151	"	"	Gray Gneiss	2	Upper Falls of Prairie River		O. E. Garrison, [107], (Near the highest exposure, east of the trail around the falls
4152	"	"	Coarse Granite	1	" "	Potsdam.	O. E. Garrison, [108], (Highest part of rock, east of the trail around the falls
4153	"	"	"	1	" "	"	O. E Garrison, [109], (From a fissure in the rock near the river, east of the trail around the falls
4154	"	"	"	1	" "	"	O. E. Garrison, [110], (From a fissure near 109)
4155	"	"	Gneiss	1	" "		O. E. Garrison, [111], (Near head of the falls
4156	"	"	Iron Ore	1	Left bank of Prairie River Falls		O. E. Garrison, [112], (From a pit dug in prospecting many years ago
4157	"	"	Iron Ore	1	Right " " "		O. E. Garrison, [113], (Near landing and trail around lower falls
4158	"	"	"	1	Prairie River Falls		O. E. Garrison, [114], (From a pit near 112)
4159	"	"	Sandstone	1	" "		O. E. Garrison, [115] (From a loose fragment in trail around lower falls)
4160	"	"	Clay	1	On Miss. R. below Prairie R		O. E. Garrison, [116], (From a bluff)
4161	April, 1880	J. B. Gilfillan	Section of large (concretion?)	1	Minneapolis	Trenton.	J. B. Gilfillan
4162	1880	P. H. Mell, Jr	Lircon	3	N. Carolina		P. H. Mell. Jr. By exchange
4163	"	"	Talc. "soapstone"	1	Bartow Co., Ga		" "
4164	"	"	Silicious Tufa	2	Flint River, Ga		" "
4165	"	"	Itacolumite	3	Mitchell Co., N. C		" "
4166	"	"	Clipiasters	3	Thomas Co., Ga		" "
4167	"	"	Blue Corundum	1	Towns Co., Ga		" "
4168	"	"	Garnets in Chlorite	2	Clay Co., Ala		" "
4169	"	"	Impure Agate	1	Flint River, Ga		" "
4170	"	"	Corundum in Zincite	1	Coosa Co., Ala		" "
4171	"	"	Albite	1	Clay Co., N. C.		" "
4172	"	"	Brown Corundum and Magnetite	6	Coosa Co., Ala		" "
4173	"	"	Grey Corundum and Tourmaline	3	Towns Co., Ga		" "
4174	"	"	Nodules, sup'sd to be chloride f'm corundum v'n	5	Coosa Co., Ala		" "
4175	"	"	Pink Corundum	8	Towns Co., Ga		" " (from trap dike)
4176	"	"	Tantalite	3	Taleapoosa Co., Ala		" " "
4177	"	"	Essonite	6	N. Africa diamond fields		" " "
4178	"	Geol & Nat Hist Sur	Section of Orthocerata	3	Vermont, Blk. R. limestone		S. F Heath
4179	"	"	Artesian-well borings, limestone 80 ft	2	Hastings, Da. Co.		Bored by W. E. Swan. I (to 80 ft)
4180	"	"	" " sandrock 15 ft	1	"		By same, II (to 95 ft)
4181	"	"	" " limestone 12 ft	1	"		" III (to 107 ft)
4182	"	"	" " sandrock 8 ft	1	"		" IV (No. 1 at 102 ft), no water
4183	"	"	" " " 10 ft	1	"		" IV (No. 2 at 122 ft), "
4184	"	"	" " " 10 ft	1	"		" IV (No. 3 at 132 ft), "

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4185	1880	Geol & Nat Hist Sur	Artesian-well borings, sandrock, 20 ft	1	Hastings, Da. Co.		Bor'd by W.E Swan IV,(No. 4 at 152 ft) } No water
4186	"	"	" " " 20 ft	1	"		By same, IV, (No. 5 at 172 ft)
4187	"	"	" " " 10 ft	1	"		" IV, (No. 6 at 182 ft)
4188	"	"	" " " 10 ft	1	"		" IV, (No. 7 at 192 ft)
4189	"	"	" " " 10 ft	1	"		" IV, (No. 8 at 202 ft)
4190	"	"	" " sandy shale 25 ft	1	"		" V, (to 227 ft)
4191	"	"	" " gray shale 43 ft	1	"		" VI, (to 270 ft)
4192	"	"	" " green shale 20 feet	1	"		" VII, (No. 1 at 290 ft)
4193	"	"	" " " 110 ft	1	"		" VII. (No. 2 at 400 ft)
4194	"	"	" " sandy shale 15 ft	1	"		" VIII, (to 415 ft)
4195	"	"	" " sandrock 20 ft	1	"		" IX, (No. 1 to 435 ft)
4196	"	"	" " " "	1	"		" IX, (No. 2 to 455 ft)
4197	"	"	" " " "	1	"		" 1st flow, IX, (No. 3 to 475 ft)
4198	"	"	" " limestone 20 ft	1	"		" X, (to 495 ft)
4199	"	"	" " blue shale 70 ft	1	"		" XI, (to 565 ft)
4200	"	"	" " green shale 20 ft	1	"		" XII, (to 585 ft)
4201	"	"	" " limestone 5 ft	1	"		" XIII. (to 590 ft)
4202	"	"	" " sandrock 5 ft	1	"		" XIV,2d flow, (No.1 to 596 ft)
4203	"	"	" " " 25 ft	1	"		" XIV, (No. 2 to 620 ft)
4204	"	"	" " " 10 ft	1	"		" XIV, (No. 3 to 630 ft)
4205	"	"	" " " 10 ft	1	"		" XIV, (No. 4 to 640 ft)
4206	"	"	" " " 10 ft	1	"		" XIV, (No. 5 to 650 ft)
4207	"	"	" " " 5 ft	1	"		" XIV, (No. 6 to 655 ft)
4208	"	"	" " " 15 ft	1	"		" XIV, (No. 7 to 685 ft)
4209	"	"	" " " 30 ft	1	"		" XIV, (No. 8 to 700 ft)
4210	"	"	" " " 7 ft	1	"		" XIV, (No. 9 to 707 ft)
4211	"	"	" " " 43 ft	1	"		" XIV, (No. 10 to 750 ft)
4212	"	"	" " " 30 ft	1	"		" XIV, (No. 11 to 780 ft)
4213	"	"	" " " 40 ft	1	"		" XIV, (No. 12 to 820 ft)
4214	"	"	" " red sandstone	1	"		" XV, (No. 1 to 835 ft)
4215	"	"	" " "	1	"		" XV, (No. 2 to 860 ft)
4216	"	"	" " red shale	1	"		" XV, (No. 3 to 870 ft)

4217	1880	Geol & Nat Hist Sur	Artesian well drillings, red sandrock	1	Hastings, Da. Co		Bored by W E Swan, XV, (No. 4 to 885 ft)
4218	“	“	“ “ red shale	1	“		By same, XV, (No. 5 to 925 ft
4219	“	“	“ “ red sandrock	1	“		“ XV, (No. 6 to 950 ft)
4220	“	“	“ “ “	1	“		“ XV, (No. 7 to 1,000 ft)
4221	“	“	“ “ “	1	“		“ XV, (No. 8 to 1,050 ft)
4222	“	“	“ “ “	1	“		“ XV, (No. 9 to 1,060 ft)
4223	“	W. D. Hurlburt.	Crinoid joints	7	Barrens of N. Alabama	(?)	Presented by W. D. Hurlburt, lowest limestone, the rotted layers still show strata
4224	“	“	Limonite	1	Olmsted Co	Upper Trenton (?	Presented by W. D. Hurlburt, Drift, cut on Eyota & Chatfield R. R
4225	“	“	Pentremites	10	Cumberland Mts. E. Tenn	Carb Sand stone	Presented by W. D. Hurlburt
4226	“	“	“Mountain Limestone,” showing crinoids	1	East Tennessee.	Sub. Carb.	“ “
4227	“	“	“ “ “ massive coral	2	“	“	“ “
4228	“	Mr. Reese.	Fossil wood, showing knot	1	Milk R. Valley, Montana		Presented by Mr. Reese
4229	1879	Geol & Nat Hist Sur	Graphite	Indf	Lake Superior		S. F. Peckham
4230	1880	“	Selenite crystals	“			U. D. Watkins
4231	“	“	Spathic Iron	1	Plymouth, Vt		“
4235	“	“	Vegetable impressions in shales	4	Cleveland, Ohio	Buyhaga shales	“ coal, No. 1
4236	“	“	Non-plastic clay	1	Bohaes, Tuscarawas Co., Ohio.		“
4237	“	“	Cone in cone	1	Cleveland, Ohio	Buyhaga shales	“
4239	“	“	Shales carbonaceous	sevl	“ “	“	“
4240	“	“	Slickinsided coal	1	Brewster bank, Akron, Ohio	“	“
4241	1881	John A. Green	“Anamosa stone”	1	Stone City, Iowa	Up. Silurian	John A. Green, Champion quarries
4242	May, 1881	Geol & Nat Hist Sur	Tellinomya levata (or fecunda, H)	24	Dubuque, Iowa	Mag. shales	Exchange with Prof. S. Calvin
4243	April, 1881	“	Copper	1	Stearns Co	Drift	O. E. Garrison, cut from a large mass
4244	May, 1881	Regent R. Chute.	Coquina	1	St. Augustine. Fla	Ter. (?)	Presented by Regent Chute
4245	1877	Geol & Nat Hist Sur	Building stone one foot square	1	Pipestone quarry Pipestone Co.	Potsdam	N. H. Winchell
4246	June, 1881	“	Limestone, believed to be hydraulic	2	Four miles north of Mankato	Shakopee	“
4247	“	“	White Clay, believed to be kaolinic	3	“ “	Cret (?)	“
4248	“	“	Limestone, showing light blue color	2	Mankato.	Shakopee	“ Maxfield's quarry, deep seated beds
4249	“	“	Elephant's tooth	1	Near the Rosebud R. Mon	Cret. (?)	Presented by S. Deutsch, (per Col. J. B. Clough)
4250	July, 1881	“	Artesian well drillings, black soil	1	Lake City		Presented by W. E. Swan, (No. 1) 2 ft.
4251	“	“	“ “ yellow clay	1	“		By same, (No. 2) 42 ft
4252	“	“	“ “ sand and gravel	1	“		“ (No. 3a) 202 ft
4253	“	“	“ “ gravel from same	1	“		“ (No. 3b) 202 ft
4254	“	“	“ “ “Hardpan”	1	“		“ (No. 4) 207 ft
4255	“	“	“ “ sand	1	“		“ (No. 5) 210 ft
4256	“	“	“ “ sand	1	“		“ (No. 6) 220 ft
4257	“	“	“ “ sand	1	“		“ (No. 7) 225 ft
4258	“	“	“ “ course sand	1	“		“ (No. 8) 232 ft
4259	“	“	“ “ sand	1	“		“ (No. 9) 290 ft
4260	“	“	“ “ sand	1	“		“ (No. 10) 360 ft
4261	“	“	“ “ sand	1	“		“ (No. 11) 405 ft
4262	“	“	“ “ sand	1	“		“ (No. 12) 412 ft
4263	“	“	“ “ sand	1	“		“ (No. 13) 422 ft

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4264	July, 1881	Geol & Nat Hist Sur	Artesian-well drillings, sand	1	Lake City		Presented by W E Swan, (No. 14), 440 ft
4265	"	"	" " sand	1	"		By same, (No. 15), 445 ft
4266	"	"	" " sand	1	"		" (No. 16), 460 ft
4267	"	"	" " sand	1	"		" (No. 17), 495 ft
4268	"	"	" " sand	1	"		" (No. 18), 500 ft
4269	"	"	" " red shale	1	"		" (No. 19), 505 ft
4270	"	"	" " " sand washed from	1	"		" (No. 20a), 525 ft
4271	"	"	" " " unwashed	1	"		" (No. 20b), 525 ft
4272	"	"	" " " sand washed from	1	"		" (No. 21a), 570 ft
4273	"	"	" " " unwashed	1	"		" (No. 21b), 570 ft
4274	"	"	" " "	1	"		" (No. 22), 600 ft
4275	"	"	" " "	1	"		" (No. 23a), 640 ft
4276	"	"	" " " sand washed from	1	"		" (No. 23b), 640 ft
4277	"	"	" " "	1	"		" (No. 24a), 680 ft
4278	"	"	" " "	1	"		" (No. 24b), 680 ft
4279	"	"	" " "	1	"		" (No. 25a), 700 ft
4280	"	"	" " " sand washed from	1	"		" (No. 25b), 700 ft
4281	"	"	" " " "	1	"		" (No. 26a), 730 ft
4282	"	"	" " " "	1	"		" (No. 27a), 773 ft
4283	"	"	" " " "	1	"		" (No. 27b), 773 ft
4284	"	"	" " "	1	"		" (28), 806 ft
4285	"	"	" " "	1	"		" (29), 830 ft
4286	"	"	" " "	1	"		" (26b), 730 ft
4287	"	"	" " black loam	1	Austin		" (1), 9 ft thick
4288	"	"	" " yellow clay	1	"		" (2), 12 ft thick
4289	"	"	" " sand and gravel	1	"		" (3), 20 ft thick,
4290	"	"	" " blue clay	1	"		" (4), 22 ft thick
4291	"	"	" " gray limestone	1	"		" (5), 44 ft thick
4292	"	"	" " gray shale	1	"		" (6), 16 ft thick
4293	"	"	" " blue limestone	1	"		" (7), 64 ft thick
4294	"	"	" " gray limestone,	1	"		" (8), 80 ft thick
4295	"	"	" " piece of limestone	1	"		" Water rose to within 9 ft of surface, from a crevice, furnishing water at 160 ft

4296	July, 1881	Geol & Nat Hist Sur	Artesian-well drillings, soil	1	Britt, Iowa		Presented by W. E. Swan, (1), 4 ft thick
4297	"	"	" " yellow clay	1	"		By same, (2), 6 ft thick
4298	"	"	" " blue clay	1	"		" (3), 75 "
4299	"	"	" " gravel	1	"		" (4), 25 "
4300	"	"	" " "hard-pan"	1	"		" (5), 14 "
4301	"	"	" " brown limestone	1	"		" (6), 57 "
4302	"	"	" " gray shale	1	"		" (7), 77 "
4303	"	"	" " limestone Mag	1	"		" (8), 298 " in this was water contained in a crevice at 470 ft
4304	"	"	" " brown carb. shale	1	"		" (9), 15 ft thick
4305	"	"	" " light limestone	1	"		" (10), 26 "
4309	"	"	Propidoleptus carinatus, Con	2	Owasco Lake, N. Y	Hamilten	S. G. Williams, by exchange
4310	"	"	Discina lodensis, Vanuxem	2	Cayuga Lake, N. Y	Genesec	" "
4311	"	"	Atrypa reticularis, var. prisca	2	Wingfield, Herk Co., N. Y	Cornif	" "
4312	"	"	Lycopodites vanuxemi. Dawson	1	Groton, N. Y	Chemung	" " (1 m N E)
4313	"	"	Strophomena rhomboidalis	1	Wingfield, Herk Co., N. Y,	Cornif	" "
4314	"	"	Pteriuea avicula glabella Con	2	Owasco Lake, N. Y	Hamilton	" "
4315	"	"	Tentaculites fissurella	1	Wingfield, Herke Co., N. Y	Marcellies	" "
4316	June, 1881	"	Sandstone	....	Sec. 8, Middleville, Wright Co	Cret ?	C. L. Herrick, rises 2 ft above Crow R
4317	"	"	"	....	Sec. 13, (?) Frankfort, "	"	" both sides Crow R
4318	"	"	Marble	1	Scranton, Vt	"	N. H. Winchell
4319	Aug., 1881	"	Hudson river shale	1	Cook's quarry, Minneapolis	Hudson R	"
4320	July, 1881	H H. Sibley	Fossils	22	Mouth of Cheyenne R., Black Hills, Da		Presented by Gen. H. H. Sibley
4321	"	"	Petrified wood	1	Dakota		" "
4322	June, 1881	Geol & Nat Hist Sur	"Molding sand,"	....	Middleville, Wright Co	Drift	C. L. Herrick, bank of Crow river
4323	"	"	Drift, characteristic of Wright Co	....	Kingstone, Wright Co	"	" banks of Crow R. 25-30 ft
4324	"	"	Sand overlying No. 4316	....	Sec. 8, Middleville, Wright Co	"	" "
4325	"	"	Rib of Manatus	1	Coosau, S. C		Prof. C. U. Shepard, obtained by exch'ge
4326	July, 1881	Geol. Survey	Tooth of horse	1	"		" "
4327	"	"	Charcharadon giganteus (tooth)	1	"		" "
4328	"	"	Charcharodon angustidens (tooth)	1	"		" "
4329	"	"	Charcharodon megalodon, etc., (teeth)	20			" "
4330	"	"	Phosphatic nodules	4	Coosau and Ashley R's, S. C		" "
4331	"	"	Fluorite (emerald green,) with titanite amphibole, etc	....	Ottawa Canada		" "
4332	"	"	Calcite, (red)	....	Grattan, Canada		" "
4333	"	"	Deweylite, with chrysotile	3	Templeton, Can		" "
4334	"	"	Zircon	Indf	Henderson Co. N. C		" "
4335	"	"	Kuebilite	2	Cumberland, R. I,		" "
4336	"	"	Danburite	3	Russel, N. Y		" "
4337	"	"	Crocoite	1	Beresof, Russia		" "
4338	"	"	Apatite	2	Templeton, Can		" "
4339	"	"	Apatite crystals	Indf	" "		" "
4340	"	"	Apatite crystals, (reddish)	4	Gratton, Can		" "
4341	"	"	Apatite	1	"		" "
4342	"	"	Apatite	1	Templeton, Can		" "
4343	"	"	Apatite, granular	1	"		" "
4344	"	"	Amphibolite and augite	2	"		" "
4345	"	"	Augite	1	"		" "

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED. When.	OBTAINED. Whence	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
4346	July, 1881	Geol. Survey	Augite	1	Jefferson Co., N. Y		Prof.C.U. Shepard, obtained by exch'ge
4347	"	"	Pelhamite	1	Pelham		" "
4348	"	"	Tourmaline, (brown,) and augite, (white)	1	Governeur, N. Y		" "
4349	"	"	Lederite and augite, (black)	1	Grutton, Can		" "
4350	"	"	Pagodite	1	Washington, Ga		" "
4351	"	"	Apatite	1	Ural mountains		" "
4352	"	"	Margarodite	1	Trumbull, Conn		" "
4353	"	"	Lederite	1	Grattan, Canada		" "
4354	"	"	Rutile	1	Graves Mt, Ga		" "
4355	"	"	Chrysotile in Deweylite	1	Templeton, Can		" "
4356	"	"	Oligoclase	1	Georgia		" "
4357	"	"	Deweylite	2	Templeton, Can		" "
4358	"	"	Fossil wood	2	Coosau, South Alabama		" "
4359	"	"	Idocrase	2	Templeton, Can		" "
4360	"	"	Tremolite in Dolomite	1	Lee, Mass		" "
4361	"	"	Kaolinite	1	Richmond Co., Ga		" "
4362	"	"	Amphibolite	1	Templeton Can		" "
4363	"	"	Vanuxemite	1	Sparta, N. Y		" "
4364	"	"	Pyrosmalite	1	Nordmark, Wermland		" "
4365	"	"	Augite	1	Ottawa Canada		" "
4366	"	"	Lederite, (Titanite)	2	Grattan, Canada		" "
4367	"	"	Pyrophyllite	5	Graves Mt, Ga		" "
4368	"	"	Cuprite mixed with sulphurets of copper	1	Siberia		" "
4369	"	"	Menilite with Glossecollite	1	Coosan, S. C.		" "
4370	"	"	Lazulite	4	Graves Mt., Ga		" "
4371	"	"	Topaz and margarodite	1	Trumbull, Conn		" "
4372	"	"	Amphibolite and calcite (red and blue)	1	Templeton, Can		" "
4373	"	"	Wilsonite	2	"		" "
4374	"	"	Anorthite, (Indianite) with specky Allanite	1	Pelham, Mass		" "
4375	"	"	Rutile	1	Graves Mt., Ga		" "
4376	"	"	Titanite	1	Arendal, Norway		" "
4377	"	"	Apatite in calcite, (red)	1	Grattan, Can		" "
4378	"	"	Calcite, (red) with apatite and biotite	1	"		" "

4379	July, 1881	Geol. Survey	Orthoclase crystals with albite	1	Huntington, Mass		Prof. C. U. Shepard, obtained by exch'ge
4380	"	"	Asbestoid Bronzite	1	Pelham, Mass		" "
4381	"	"	Tremolite	1	Cherokee Co., N. C		" "
4382	"	"	Apatite	2	Grattan, Can		" "
4383	"	"	Phosph	2	Spain		" "
4384	"	"	Augite Chromiferous	1	Wakefield, Conn		" "
4385	"	"	Phosphatic nodules, "land phosphate."	1	Ashley Region, S. C		" "
4386	"	"	Pyrula carica	2	Young's Id., S. C	P'st Pliocene	" "
4387	"	"	Oliva litorata	7		"	" "
4388	"	"	Natica duplicata	Indf	"	"	" "
4389	"	"	Artemis concentrica	3	"	"	" "
4390	"	"	Arca incongrua	5	"	"	" "
4391	"	"	Lutrasia canaliculata	6	"	"	" "
4392	"	"	Terebra acuta	Indf	"	"	" "
4393	"	"	Mactra sunilee	1	"	"	" "
4394	"	"	Sigarelus perspectivus	1	"	"	" "
4395	"	"	Scalaria	1	"	"	" "
4396	Oct., 1881	"	Squared slab of roofing slate	1	Near Knife Falls	Huronian	N. H. Winchell, (12 in by 26 in by 2 in)
4397	"	"	Hudson River limestone	2	Clinton Falls	Hud R	" { (taken for building stone tests
4398	"	"	Blue sandsrock, (building stone.)	2	Dresbach	St. Croix	"
4399	"	"	Buff sandrock, (building stone.)	1	Dakota	"	"
4400	"	"	Yellow sandrock, (building stone.)	16	Near Fort Snelling	"	"
4401	Aug., 1878	"	Basaltic columns, (triangular.)	3	Grand Marais		C. W. Hall, { Fr'm the natural breakwater, Grand Marias harbor
4402	"	"	" (four-sided.)	4	"		"
4403	"	"	" (five-sided.)	1	"		"
4404	"	"	" (six-sided.)	1	"		"
4405	Oct., 1881	C. W. Hall	Quartzyte	2	Devil's Lake, Wis	Potsdam	C. W. Hall, (from cut on C. & N. W. Ry.)
4406	July, 1881	C. M. Terry	Kaolin	3	Aiken, S. C		C. M. Terry presented
4407	Nov., 1881	C. U. Shepard	Meteoric stone, (fell Oct. 13, 1879.) wt 1.75 grains	1	Soko Banjia, Servia		Prof. Shephard, obtained by exch'ge
4408	"	"	" (fell May 22, 1808,) wt 1.48 "	2	Stannern		
4409	"	"	" (fell 1871.) wt 1.4 "	2	Searsport, Me		" "
4410	"	"	" wt 1.35 "	1	Little Piney, Mo		" "
4411	"	"	" wt 2.1 "	1	Milena		" "
4412	"	"	Meteoric Iron wt 14.55 "	1	Disco, Baffins Bay		" "
4413	"	"	" (fragments) wt 2.52 "	Indf	Sarepta		" "
4414	"	"	" wt 0.63 "	1	Union Co., Ga		" "
4415	"	"	" (fell 1875) wt 18.35 "	1	Santa Catarina, Brazil		" "
4416	"	"	" wt 4.55 "	1	Bitburg, Prussia		" "
4417	"	"	" wt 24.97 "	1	Auburn, Ala		" "
4418	"	"	" wt 17.5 "	1	Lexington, S. C		" "
4419	"	"	" wt 8.4 "	1	Durango		" "
4420	"	"	" wt 1.98 "	1	Ivanpah, Cal		" "
4421	"	"	" wt 2.3 "	7	"		" "
4423	Oct., 1881	Geol Survey	Pink Quartzyte	1	Sioux Falls, Dak	Potsdam	N. H. Winchell
4424	May, 1881	"	Sassolite	1			"
4425	"	"	Sandstone with lingulae and galenite	12	Dresbach	St. Croix	" (Dresbach's Mine)
4426	Sept., 1881	"	Pressed brick, red	1	Red Wing		

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4428	Sept., 1881	Geol. Survey......	Fine-grained, gray granite......................	1	S. E. ¼ Sec. 34, 43, 23, Aitkin Co	....	Warren Upham....................
4429	"	"	Granite, light-colored........................	1	Sec. 4, 42, 23, Kanabec Co......	....	" ½m N of the mouth of Cowan's Cr........
4430	"	"	Dark Mica-schist...........................	1	" "	....	" ½m N of the mouth of Cowan's Cr.........
4431	"	"	White quartzose granite......................	1	Sec. 9, 42, 23, "	....	" Typical rock at the "Jaws of the Upper Falls," Snake River
4432	"	"	Coarse red granite, (superficially red)..........	1	" "	....	" "Jaws of the Upper Falls" of Snake R..
4433	"	"	Gneiss......................................	1	" "	....	" 30 rods S of "Upper Falls" of Snake River.............
4434	"	"	Homogeneous, fine, gray, granite....	1	" "	....	" 60 rods S of "Upper Falls" of Snake River............
4435	"	"	Red granite, enclosing a micaceous mass.......	1	Sec. 16, T. 42, 23 "	....	" 60 rods above head of Lower Falls........
4436	"	"	Fine, homogeneous, white granite..............	2	Sec. 15 & 16, T 42,23 Kanabec Co	....	" Upper part of Lower Falls of River, the prevailing rock here
4437	"	"	Mica schist..................................	3	" "	....	" Cent'l p't Lower Falls
4438	"	"	Hard mica schist, attached to dark gneiss......	1	" "	....	" " "
4439	"	"	Fragile mica schist..........................	1	" "	....	" " "
4440	"	"	Quartz, vein in mica schist..................	1	" "	....	" Lower Falls, Snake R
4441	"	"	Redish-gray granite..........................	3	S.E. ¼ Sec. 30, T. 40, 24, "	....	" At Ann Lake dam....
4442	"	"	" "	2	S.W. ¼ Sec 29, T. 40, 21, "	....	" At Roll dam, Ann R
4443	"	"	Dark gneiss, (red feldspar)....................	4	N. W. ¼ Sec. 24, T. 41, 31, Morrison Co......................	....	" BellePr'ie, MorrisonC"
4444	"	"	Coarse gneiss, (white feldspar)................	9	Sec. 21, T. 41, 29, Morrison Co..	....	" "Granite City".......

4445	Sept., 1881	Geol. Survey......	Fine, red granite..................................	5	S.E.¼ Sec.35, T.41, 29, Morrison Co	....	Warren Upham,	N. end big dam, Hillman brook.......
4446	"	"	Coarse gneiss, (white feldspar and biotite)......	2	" "	....	"	S. end big dam, Hillman brook.........
4447	"	"	Gneiss, (white feldspar and biotite).............	2	N. W.¼ Sec. 18, 40, 29 "	....	"	N end lower Roll dam, Hillman brook.....
4448	"	"	Micaceous granite, (white feldspar and biotite)	2	N. E. ¼ Sec. 9, 40, 30, Pierz, Morrison Co..........	....	"	1 m E of Rich Prairie, E side Skunk R. . ..
4449	"	"	Micaceous gneiss, " "	2	" "	....	"	" "
4450	"	"	Dark micaceous granite, (gneissic)........... ..	6	Sec's 18 and 7, T. 41, 30, Morrison Co..........................	....	"	1 m. W. of Platt R....
4451	"	"	Coarse, gray granite, (gneissic).............	4	S. W. ¼ Sec. 17, T. 40, 30, Morrison Co......	....	"	....
4452	"	"	Fine, gray granite, (homogeneous).............	17	S. E ¼ Sec. 13, T. 40, 31, Morrison Co.......................	... .	"	¼ m. S. of Fish Lake
4453	"	"	Coarse, red syenite..............................	4	N. W. ¼ Sec. 18, T. 39, 30, Morrison Co................	....	"	Buckman twp.......
4454	"	"	"	1	Sec. 29, T. 38, 27, Mille Lacs Co	....	"	W. br. of Rum R.....
4455	"	"	"	2	" "	....	"	W. br. Rum R ¼ m. N. W. from last.......
4456	"	"	"	2	Sec. 19, T. 38, 27, "	....	"	Stony Brook dam, W. br. Rum R.........
4457	"	"	Fine, red syenite, (dyke-like)................	1	Sec. 24, T. 38, 28, Benton Co....	....	"	W. br. Rum River....
4458	"	"	Coarse, red syenite, (50 rods W. of last).........	2	" "	....	"	W. br. Rum R., 25 rods W. of Roll dam.....
4459	"	"	Fine, red granulite, (compact)................	2	N. E. ¼ N. W. ¼ Sec. 20, 38, 28, Benton Co...............	....	"	N. of the trap dyke...
4460	"	"	Fine, dark trap, (from a dyke)..................	2	" "	....	"	....
4461	"	"	Coarse, red syenite............................	2	" "	....	"	S. of the trap dyke....
4462	"	"	Porhyritic, red syenite....	4	S. E. ¼ S. W ¼ Sec. 18, 37, 29 Benton Co....................	....	"	Clement Teller's land
4463	"	"	Coarse, micaceous syenite, (white feldspar)....	2	N. E.¼ Sec. 35, 37, 31. Benton Co	....	"	Used in Bismarck b'ge
4464	"	"	Fine, light granite..............................	2	" "	....	"	" "
4465	"	"	Coarse, red syenite..............................	2	" "	....	"	" "
4466	"	"	Micaceous syenite, (gray)......................	4	Sauk Rapids, Benton Co........	....	"	Collins, Mitchell & Searle...............
4467	"	"	" (showing lumbs of dark)...	1	" "	....	"	" "
4468	"	"	Reddish granite, (Porphyritic with albite?).....	4	1 m. E. Sauk Rapids, Benton Co	....	"	25r'sS Gilmanton road
4469	"	"	Coarse, red syenite..............................	4	N. ½ Sec. 11, " "	....	"	Quarry of Collins, Mitchell & Searle...
4470	"	"	Coarse, reddish-gray syenite....................	4	" " "	....	"	From the deeper parts of quarry of Collins, Mitchell & Searle...
4471	"	"	Coarse, red syenite, (has some mica)...........	2	S.E.¼ Sec.11, " "	....	"	Wm. Kout's..........
4472	"	"	" " "..........	3	N.W.¼ Sec.18, " "	....	"	E. D. Learned estate
4473	"	"	Dark, fine, trap-rock; dyke 1 ft wide..........	3	" " "	....	"	Cuts No. 4472, E. D. Learned estate.....
4474	"	"	Fine, mixed, (reddish-gray) syenite...........	4	S.W.¼ Sec.13, " "	....	"	R. W. Leyerly.......
4475	"	"	Fine, red syneite..................................	4	N.E. ¼ Sec.14, " "	....	"	Joseph Moody........

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.	
	When.	Whence.						
4476	Sept., 1881	Geol. Survey	Coarse, red syenite	1	N. E. ¼ Sec 14, Sauk Rapids, Benton Co		Warren Upham, Joseph Moody	
4477	"	"	Fine, gray syenite	2	2 m. S. E. of St. Cloud bridge		"	Quarry of Breen & Young
4478	"	"	" (hammered face)	1	" "		"	"
4479	"	"	Red syenite	6	" "		"	"
4480	"	"	Porphyritic, coarse, gray syenite	4	20 rods S. of Sauk Rapids bridge		"	W. side of Miss River.
4481	"	"	Gray syenite	4	1 m. S. of St. Cloud bridge		"	"
4482	"	"	Gray syenite, (reddish)	4	S. W. ¼ Sec. 20, St. Cloud		"	Nicholas Scheuer
4483	"	"	Coarse, red syenite	2	" "		"	Matthias Leine
4484	"	"	Gray syenite	4	N. E. ¼ Sec. 28 "		"	Jacob Streitz
4485	"	"	Reddish-gray, fine syenite	4	N. W. ¼ Sec. 28, "		"	Louis Hohmann
4486	"	"	" "	4	N. E. ¼ Sec 29, "		"	Fred Hartman
4487	"	"	Coarse, red syenite	4	" "		"	"
4488	"	"	Fine, pink syenite	3	Sec. 7, N E. ¼, Le Sauk, Stearns Co		"	
4489	"	"	Coarse, red syenite	1	Melrose, Stearns Co		"	Ed Clark's mill is founded on this
4490	"	"	Dark dioryte, (6 feet below surface)	4	W. side Melrose, Stearns Co.		"	W. H. Rothsermel's well
4491	"	"	Coarse, Pink syenite,	1	Sauk Center, Stearns Co		"	¼ m S. E. d'p't, S side Ry
4492	"	"	Fine, pink syenite	1	" "		"	"
4493	"	"	Fine, pink syenite, including mass of mica schist	1	" "		"	"
4494	"	"	Red syenite	1	" "		"	"
4495	"	"	Dark dioryte, (N. W. from last)	2	" "		"	"
4496	"	"	Dark dioryte	1	" "		"	From a well at Barnum's Block
4497	"	"	Pink syenite ? (containing a green mineral)	1	Sec. 17 & 18, Ashley, Stearns Co		"	
4498	"	"	Greenish syenite ?	8	" "		"	Contains more of the green mineral
4499	"	"	Green syenite ?	1	" "		"	Contains much of the green mineral
4500	"	"	Coarse, feldespathic, white syenite	1	" "		"	Contains some of the green mineral

4501	Sept., 1881	Geol. Survey	Gray syenite	9	N. E. ¼ Sec. 15, 131, 33, Todd Co		Warren Upham	
4502	"	"	Gray syenite, showing green veins	2	" "		"	
4503	"	"	Gray syenite	4	N. E. ¼ Sec. 28, 134, 32, Cass Co.		"	5 m. N. W. from Motley
4504	"	"	Micaceous syenite	4	" "		"	"
4505	"	"	Dark traprock	4	" "		"	Cutting the last
4506	"	"	Gray, hard slaty quartzyte	2	1 m. N. of Moose L. Station, Carleton Co.		"	Much jointed into rhombic masses
4507	"	"	Hydro-mica schist	7	¼ m S. S. W. Moose Lake Sta., Carelton Co.		"	
4508	"	"	Traprock in schist	2	¼ m. W. of Moose Lake Station, Carleton Co.		"	
4509	"	"	White quartz in Hidro-mica schist	2	¼ m. S. S. W. Moose Lake Station, Carleton Co.		"	
4510	"	"	Hardened gray quartzyte, semi-crystalline	1	Little Falls, Morrison Co		"	4 rds N. of E. end ferry
4511	"	"	White quartz in vein 1 ft wide	1	" "		"	6 "
4512	"	"	Fine-grained, staurolitic mica slate	10	" "		"	E. shore, at falls dip, 15° N. W.
4513	"	"	Mica slate, (shows sedimentation)	1	" "		"	"
4514	"	"	Granetiferous fissile, mica slate	3	" "		"	
4515	"	"	Mica schist, (fine)	4	" "		"	
4516	"	"	Dioryte, (coarse)	1	" "		"	At "the point"
4517	"	"	Gray, fine, semi-crystalline, slaty rock	5	N. E. ¼ Sec. 7, T. 130, 30, Morrison Co		"	Finely micaceous but not slaty
4518	"	"	" "	1	" "		"	Finely micaceous, (pyritiferous)
4519	"	"	Fine, mica slate	6	Near the mouth of Little Elk R.		"	Shows sedimentation.
4520	"	"	White quartz, (in slate)	1	" "		"	
4521	"	"	Micaceous dark dioryte	3	N. E. ¼ Sec. 13. T. 129, 30, Morrison Co.		"	W. of Little Falls
4522	"	"	" "	2	" "		"	" (light)
4523	"	"	" "	1	" "		"	" (lighter)
4524	"	"	" "	2	" "		"	" (lightest)
4525	"	"	Porphyritic, micaceous, hornblende rock	2	" "		"	W. of Little Falls
4526	"	"	Micaceous dioryte, (fine)	1	" "		"	Contains a decaying green mineral
4527	"	"	Mica schist, (with staurolite)	5	Pike Rapids, Morrison Co		"	
4528	"	"	" "	2	N. E. ¼ 32, T. 128, 29, Morrison Co.		"	Land of C. Gilpatrick.
4529	"	"	Dark compact, (chrysolite bearing?) rock	4	S. E. ¼ 32, T. 128 29, "		"	Allen Blanchard
4530	"	"	Staurolitic mica schist, (coarse)	6	Sec's 17 & 18, Bellevue "		"	E. shore Miss. R., (I. P. Lambert
4531	"	"	Fine, mica slate	6	S. E. ¼ Sec. 4, T. 128, 30, "		"	At Ledoux bridge
4532	"	"	Dark, compact pyritiferous rock, (Dioryte?)	2	Sec. 34, T. 133, 32, Todd Co.		"	Mouth Fish trap br'k.
4533	"	"	" " "	1	" "		"	¼ m. above mouth of Fish trap brook
4534	"	"	Mica schist, (finely garnetiferous?)	1	Sec. 34, T. 133, 32, "		"	Mouth Fish trap br'k.
4535	Oct., 1881	"	Rotting amydaloidal trap	2	Sec. 22, T. 41, 20, Pine Co.	Cupriferous	"	Northern outcrop
4536	"	"	" "	3	" "	"	"	Southern outcrop
4537	"	"	Copper strained rock	2	S. part Sec 32, T. 40, 19, Pine Co.	"	"	At E bow of Kettle R.
4538 a	"	"	Coarse spar, (carb lime)	2	" "	"	"	"
4538 b	"	"	Laminated pearl spar, (carb lime)	12	" "	"	"	"
4539	"	"	Siliceous nodule, (parti colored)	1	N. W. ¼ Sec. 4, T. 39, 19, Pine Co.	"	"	

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4540	Oct., 1881	Geol. Survey......	Melaphyr....................................	1	N. W. ¼ Sec. 4, T. 39, 19, Pine Co.	Cupriferous	Warren Upham, W. side of Kettle R..
4541	"	"	Fine, trap-rock....................................	1	Sec. 17, T. 39, 19, Pine Co.......	"	" S. end of Big Island..
4542	"	"	"	2	N. W. ¼ Sec. 29, 39, 19, Pine Co	"	" W. shore St. Croix R..
4543	"	"	Core of diamond drill, (trap)...................	1	S. W. ¼, N. W. ¼ Sec. 25, 39, 21, Pine Co................	"	" Chengwatona Mining Co.. ....
4544	"	"	From 50 ft. vein, (said to bear copper)..........	1	" "	"	" "
4545	"	"	Calc spar in trap-rock...........................	4	" "	"	" "
4546	"	"	Greenish trap, with calc spar...................	3	" "	"	" "
4547	"	"	Green amydagloidal trap, (has Thalite)........	2	" "	"	" "
4548	"	"	" " "	2	" "	"	" "
4549	"	"	Trap-rock, with spar crystals..................	2	" "	"	" "
4550	"	"	Calcite crystals..................................	2	" "	"	" Eugene L. Wilcox....
4551	"	"	Red conglomerate, (3d belt)......................	2	¼ m. E of Chengwatona........	"	" Strike N. 15°, E. dip 70°,S.75°,E 30 ft thik
4552	"	"	Pinkish sandstone.......	2	S. part Sec, 34, T. 43, 20, Pine Co	St. Croix.	" Ravine W. of Kettle R.
4553	"	"	Coarse, pinkish sandstone........................	3	S. part Sec. 15, T. 42, 20, "	"	" Brink of Lower Falls, Kettle R............
4554	"	"	Coarse gritstone.................................	1	¼ m. S. of mouth Grindstone R..	"	" W. side of Kettle R...
4555	"	"	White sandstone...................................	1	S. E. ¼ Sec. 30, 39, 19, (Wis.)....	"	" E. of most south'n of "Thousand Islands.'
4556	"	"	Argillaceous, red sandstone.........	1	" "	"	" "
4557	"	"	White sandstone..........	2	N. E. ¼ Sec. 36, T. 39, 20, Pine Co	"	" Used for court house found'n, Grantsburg
4558	"	"	Red sandstone, (with pebbles)......	4	N. part Sec. 28, T. 42, 23, Kenabec Co........................	Potsdam.	" E. bank of Snake R...
4559	"	"	" (with coarse pebbles)...........	3	" "	"	" " "
4560	"	"	" (with dark and light spots).....	1	" "	"	" " "
4561	"	"	Calcareous, concretionary shale, (gray)..	4	Two Rivers, Morrison Co.......	Cretaceous.	" W. shore Miss. R, 25 rods N. of mouth of main two rivers....
4562	"	"	Ferruginous, concretionary shale, (spongy)...	1	" "	"	" " "
4563	"	"	" " " (compact)...	1	" "	"	" " "

4564	Oct., 1881	Geol. Survey	Lignitic clay	4	Two Rivers, Morrison Co.	Cretaceous.	War'n Upham	S. E. side main two rivers, 1-10 m. above mouth
4565	"	"	Lignite lumps in lignitic clay	1	" "	"	"	" "
4569	"	"	Cone-in-cone	2	" "	"	"	40 rods S. E. of mouth of main two rivers, on W. shore Miss. R.
4570	"	"	Block of bluish clay	1	4 m. E. of Luverne	"	"	From depth of 356 ft. in Rock Co. Farming Co's well
4571	"	"	Pebbles of limestone and shale	10	" "	Drift.	"	From Rock Co. Farming Co's well
4572	"	"	Soil, (thought to be saline)	1	N.W.¼ Sec.29, 159.48, Kittson Co.	"	"	
4573	"	"	Coal, (contained in sand 141-157 ft below surface.	1	N. E. ¼ Sec. 29, 146, 46, Norman Co.	"	"	From Lockhart farm.
4574	"	"	Dark concretionary mass from the soil	1	Sec. 26, 41, 31, Morrison Co.	Drift.	"	Found in plowing by J. W. Tanner
4575	"	"	Gray till, above the blue till	1	Sec. 8, T. 127, 29, "	"	"	Young Bro's mill, main two rivers
4576	"	"	Blue till	1	Sec. 8, T. 127, 29, "	"	"	" "
4577	"	"	Gray till	1	St. Francis bridge, Anoka Co.	"	"	E. bank of Rum River.
4578	"	"	Red till, (underlying No. 4577)	1	" " "	"	"	" "
4579	"	"	Red till	1	Sec. 16, T. 121, 24, Wright Co.	"	"	Well of David Bagley, 4.m. E. Monticello.
4580	"	"	Porphyritic hornblende schist	2	Sec. 12, T. 140, 46, Clay Co.	"	"	From a boulder 15 ft x 12 ft. x 5 ft.
4581	"	"	Perforated, water-worn boulder	1	Sec. 7, 129, 29, Morrison Co.	"	"	2. m. N. W. of Little Falls R. J. Lambert's well
4582	"	"	Perched rock, standing on No. 4450	1	Sec. 7, T. 41, 30, "	"	"	Standing on 3 points, (8 ft. in diam.)
4583	"	"	From a boulder of syenite, (like Watab)	1	Sec. 23, T. 42, 23, Kenabec Co.	"	"	On Snake River
4584	"	"	Pebble of conglomerate.	1	Mout of Snake River	"	"	
4585	"	"	Pebble of red conglomerate.	1	Sec. 6, T. 38, 19, Pine Co.	"	"	Contains red shale
4586	"	"	Compact mottled limestone	1	Sec. 1, Springvale, Isanti Co.	"	"	Found in slabs 10-20 feet long
4587	"	"	Garnetiferous mica schist	4	Sec. 7, Palmer, Sherburne Co.	"	"	From a bou der 25x30 x20 ft.
4588	"	"	Banded, red, jasper pebble	1	Sec. 28, Sauk Rapids	"	"	With other pieces, 1 ft. long
4589	"	"	Pebbles, (crystalline rocks)	10	N. E. ¼ Sec. 26, T. 39, 24, Konabec Co.	"	"	From Fish Lake dam.
4590	"	"	Beach pebbles " "	45	N. W. shore of Mille Lacs, Crow Wing Co.	"	"	Characteristic of shore
4591	"	"	Hollowed pebble, (rounded)	1	" " "	"	"	
4592	"	"	Beach pebbles, (some limestone)	40	N. E. side L. Alexander, Mor. Co.	"	"	Characteristic of shore
4593	"	"	Pebbles from top of Hole in the Day's Bluff	20	N. W. ¼ Sec. 36, T. 41, 32, "	"	"	1¼ m. N. E. Litt'e Falls, no limestone.
4594	"	"	Pebbles, (considerable limestone)	10	Sec. 5, 127, 29, Mor Co.	"	"	1¼ m. N. Two Rivers
4597	"	"	Concretionary nodule from the Cretaceous	8	Sisseton Agency, Dak	"	Thomas M. Young,	1½ m. E of school.
4598	"	"	Coarse granite, with tourmaline	1	" "	"	"	On Coteau de prai'e.

Specimens Registered in the Museum in 1881—Continued.

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4599	Oct. 1881	Geol. Survey......	Annular section of concretion in pebble........	1	8 m. W. Sisseton Agency, Dak.	Drift.......	Warren Upham, summit of Coteau de Prairie..................
4600	"	"	Fine, yellow clay, (for brick)................	3	Sec. 26, T. 127, 34, Todd Co ...	"	" E. shore Big Sauk L. 3 m. N. E. of Sauk Center..........
4601	"	"	Dark clay, (laminated and fine)	2	" "	"	" " " "
4602	"	"	Irony, cylindrical concretions.	2	" "	"	" From Pangburn & Moore,s brick clay................
4603	"	"	Limy, flat concretions........................	2	" "	"	" " " "
4604	"	"	Fragment of large bone.......................	1	" "	"	" 10 feet below surface in Pangburn & Moore,s brick clay.
4605	"	"	Red brick....................................	1	2 m. S. Rush City, Chisago Co.	....	" Near R.R., Spooner & Hayden.
4606	"	"	"	1	Sec. 8, T. 133, 32, Todd Co....	....	" H.B. Morrison, 5 m. W. Motley.
4607	"	"	"	1	S.W ¼ Sec. 8 T. 133, 35, Todd Co.	....	" Murray & Allen, 7 m. S. Wadena
4608	"	"	Cream brick..................................	1	Sec. 35, T. 131, 34, Todd Co....	....	" G G. Howe, 1½ m. S.E. Clarissa.
4609	"	"	Well " (cream)........................	1	" "	....	" " " "
4610	"	"	Pink "	1	Sec. 26, T. 127, 34 "	....	" Pangburn & Moore 3 m N. of Sauk Center..............
4611	"	"	Red "	1	Sec. 22, St. Cloud, Stearns Co..	....	" Greven & Lommel..........
4612	"	"	Cream "	1	Sec. 26, " " ..	....	" Wm. Kruegel...............
4613	"	"	" "	1	" " " ..	....	" Frederick Kuhne...........
4614	"	"	Red "	1	Sec. 12, Otsego, Wright Co....	....	" Ingersoll Bros.............
4615	"	"	Cream "	1	Sec. 20, Grow, Anoka Co.......	....	" Kelsey Bros., 3 m. N.E. Anoka.
4616	"	"	Well " (cream........................	1	" "	....	" " " "
4617	"	"	Cream "	1	Crookston, Polk Co...........	....	" Norris & McDonald..........
8618	"	"	" "	1	" "	....	" W. A Norcross.... ....
4619	"	"	Pink "	1	Breckinridge, Wilkin Co........	....	" Jos. Hall, E. bank Red R.....
4621	Aug, 1881	"	Magnesian limestone....	1	Dresbach......................	St. Law'nce	N. H. Winchell................
4628	1880	Exchange	Sassolite, lamelated & vitreous, (original No. 1)	1	Tuscany.	....	In a bottle....................
4629	"	"	Alunogen, yel'w & conretionary ..(" No. 2.)	1	Ariege, France..	....	....
4630	"	"	Anhydrite, violet, lamellated....(" No. 3.)	1	"	....	....
4631	"	"	Cerargyrite, on ferruginous barite(" No. 4.)	1	Chili..........................	....	With gray copper and haematite.....
4632	"	"	Aragonite prismatic,..........(" No. 5.)	1	Saragossa, Spain........... ...	....	Crystallized with red quartz.........

4633	1880	Exchange	Bismuth, native, lamellated,...(“ No. 6.)	1	Saxony		With arsenical cobalt and arsenate of cobalt
4634	“	“	Smalttie (“ No. 7.)	1	Sweden		Fragment of split crystal
4635	“	“	Apatite, white (“ No. 8.)	1	Ariege		Concretionary, also brownish and amorphous
4636	“	“	Gypsum in 2 crystalline sheets,(“ No. 9.)	1	Montmartre		Reflecting from an incrustation of iron.
4637	“	“	Calcite quartziferous (“ No. 12.)	1	Fontainbleau		Sharply rhombohedral, crystals of Fontainbleau
4638	“	“	Freieslebenite, gray (“ No. 15.)	1	Hiendelaencina		Amorphous, on gneiss
4639	“	“	Noumeaite, (hyd. Sil. Nickel)..(“ No. 17.)	1	Noumea, New Caledona		In a network of concretionary quartz.
4640	“	“	Rhodonite (“ No. 18.)	1	Spain		With black sulphate of manganese and quartz
4641	“	“	Sulphur and celestite (“ No. 19.)	2	Sicily		Prismatic celestite, (on a bluish marl).
4642	“	“	Bornite, massive (“ No. 20.)	1	Chili		Massive, variegated copper
4643	1881	Presented	Gold in quartz	1	Black Hills		Presented by D. A. Locke, (Bengal Tiger Mine
4644	“	By Exchange	Spodumene	1	Sterling, Mass		
4645	“	“	Damourite, (sterling)	1	“		
4646	“	Presented	Slabs with Lingula Melei and Discina Newberryi	3	Berea, O.	Cuy. Shale	C. W. Hall
4647	1877	Geol. Survey	Pebbles of red quartzyte in the quartzyte	1	Pipestone quarry	Potsdam	N. H. Winchell
4668	1881	“	Mass of Selenite crystals, (original No. 21.)	1	Lit. Missouri Cantonment	Ter ?	“ from Dr. Miller
4676	1878	“	Calcareous geode	1	Dakota Territory	Cretaceous	C. A. Morey
4677	1881	Exchange	Freieslebenite	1	Spain		With barite, drusy quartz and siderite.
4678	“	Geol. Survey	Ripple marked slab of red quartzyte	1	Pipestone quarry	Potsdam	Warren Upham, presented by C. H. Bennett
4679	“	“	Building stone block 1 foot square	1	Stone City, Jones Co., Iowa	Niagara	N. H. Winchell, J. A. Green's quarry.
4680	“	H. S. Peters	Quartz crystals, twinning and overlying	1	Herkimer, Herkimer Co., N.Y.		Presented by H. S. Peters
4681	1880	Presented	Graphite	1	Heath, Mass		
4682	“	“	Corundum, (Emery)		Plymouth, Ct		
4683	“	“	Granite		“		
4684	1881	Geol. Survey	Drilling from deep well, Minneapolis in glass tube		Minneapolis		Well at Washburn C mill, 205 feet, (C. E. Whelpley)
4685	1880	“	“ “ “ “ in a glass tube at Emmettsburg, Iowa		Emmetsburg, Iowa		Well is 869 ft., (pres. by W E. Swan)
4690	1881	J. B. Clough	Elephant's tooth, (15 inches long)	1	Near the Rosebud River, Mon.		Presented by J. B. Clough

ARCHÆOLOGICAL ADDITIONS TO THE MUSEUM IN 1881.

58. Hair of a native of the New Hebrides. Two braids.

59. Two chalcedony arrow points, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

60. One chalcedony spear point, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

61. Two chert arrow points, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

62. One iron arrow-point, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

63. Small stone hammer, withed. From Michigan. Presented by N. H. Winchell.

64. One Indian stirrup, ornamented with white beads. Presented by Col. J. B. Clough.

65. One stone slab, 18 inches in length, apparently used for rubbing and tanning skins. From Dakota. Presented by Col. J. B. Clough.

66. One hickory bow and rawhide case, with rawhide quiver containing seven arrows, five of them with iron points. From Miles City, Montana. Presented by Col. J. B. Clough.

67. An Indian weapon—a quartz pebble surrounded by a rawhide withe which is extended into a handle about three feet long, terminating with a loop for the wrist, and stiffened by a flexible stick. From Miles City, Montana. Presented by Col. J. B. Clough.

68. Small. perfect arrow-point of quartzose, oolitic, or concretionary chert. Found on the University campus by Mr. Fisher, and by him presented to the University Museum.

69. Stone ax, withed, of dark dioryte, found near Albert Lea. Presented by Rev. L. J. Hange.

70. Pangue knife, from the Ogove river, Africa, said to be made of "native iron," enclosed in a snake-skin sheath. Presented by Rev. G. C. Campbell.

71. Loom and three yards of cloth, made from bast fiber, by the *Ivilli*, of the Ogove river, Africa. Presented by Thos. Sinclair, trader on the Ogove river, through Rev. G. C. Campbell.

72. Native dress, worn by the *Ivilli*, and others up the Ogove river, Africa. Presented by Thos. Sinclair, trader, through Rev. G. C. Campbell.

73. Prehistoric Maize, from the old cemetery near Madisonville, Hamilton county, Ohio. Presented by N. H. Winchell.

VI.

GEOLOGICAL NOTES ON MINNESOTA.

BY MR. J. H. KLOOS.

[Translated by N. H. Winchell.]

[NOTE.—These notes were made by Mr. Kloos when serving as Land Agent of the St. Paul & Pacific R. R. and were published in the *Zeitschrift d. Deutschen Geologischen Gesellschaft*, p. 417. They furnish the basis for the subsequent investigations of Streng and Kloos on the crystalline rocks of Minnesota, and contain original observations on the stratigraphical relations of the formations, which differ from those of his predecessors, particularly on the trap and sandstone at Taylor's Falls. They furnish an important historical link between the surveys of Owen, Whittlesey and Eames, and the beginning of the present survey.]

Since the publication of the geological survey carried on under the direction of the American geologist, David Dale Owen, little that is noteworthy has appeared on the geology of Minnesota.

Owen with his assistants, Norwood, Shumard, Whittlesey and eight others, explored the States of Wisconsin, Iowa and Minnesota from 1847 to 1850. In his report to the government of the United States he gives a careful description of the country in respect to its geography and geology, its fauna and flora, as well as its agricultural resources. The 638 pages of his heavy quarto volume contain a vast amount of valuable and exact observations, especially upon the northern part of the district examined, in which even yet exploration is attended usually with great difficulties. A fault of the work is its petty simplicity. The detailed descriptions of many river-valleys, in respect to topography and climatology, render difficult the attainment of a general view of the geology. The description of the crystalline rocks of Minnesota, which in many respects possess a high importance, is faulty. Also the palæontological subjects are not thoroughly treated, and the illustrations of new species published by Owen possess little merit.*

In the year 1866† appeared a little pamphlet on Minnesota by Charles Whittlesey, formerly an assistant of Owen. It is confined almost entirely to the shores of Lake Superior, and describes the conditions and appearance *in situ* of copper and other metals.

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*Report of a Geological Survey of Wisconsin, Iowa and Minnesota, by authority of Congress, by David Dale Owen, Philadelphia, 1862.

†A report of explorations in the mineral regions of Minnesota during the years of 1849, 1859 and 1864, Cleveland, 1866.

The examinations by the State Geologist, Henry H. Eames, pertain exclusively to those parts of Minnesota in which copper, iron and small quantities of gold are found. In his report for 1866 he confines himself to the description of the occurrence of the useful metals and their ores.*

An important paper on the geognosy of southwestern Minnesota was published by Prof. James Hall in the year 1866. His design was to examine the outcrop of coal on the Cottonwood river, one of the important tributaries of the St. Peter or Minnesota river. Owen with his assistants had been only to the mouth of the Cottonwood. Hall penetrated as far as the celebrated locality where the Indians obtained the "Pipestone" for their pipes.† He shows that the coal outcropping there belongs to a younger formation—viz.: the Cretaceous—and assumes the former extension of the Cretaceous as well as the older Mesozoic strata, over that part of Minnesota. At the same time he offers some valuable observations upon the crystalline and metamorphic rocks which appear along the Minnesota river above the mouth of the Cottonwood.‡

In the following I have sought to gather together in a comprehensive survey my various notes on different parts of Minnesota; and where it has been necessary to a comprehension of the description, and I was not able personally to make examinations, I have filled them out from earlier observations of others. By means of the map I have aimed rather to aid the reader than to present an exhibition of the geological conditions. The points of observation are in the river valleys, separated by wide tracts covered by drift, and we are not at this time in condition to announce with any certainity the boundaries of the formations. I have gathered much material which is designed for a more careful investigation at some later time, and if time and opportunity are afforded me I aim to treat the separate subjects more thoroughly, which now can only be mentioned briefly.

The State of Minnesota in the geographical center of the continent of North America, lies between 43½ and 49 degrees of north latitude, and between 89½ and 97 degrees of west longitude. This member of the American Union is bounded on the south by Iowa, on the east by Wisconsin, north by the Winnipeg district of British America, and westerly by the territory of Dakota. The area of the state embraces 84,000 English square miles.* A wide wedge, jutting toward the east, extends between Lake Superior and the Rainy lake river which with a succession of small fresh-water lakes forms the boundary line along British America. Therefore Minnesota has a coast line of 160 miles, and a position extremely favorable for trade with the eastern States.

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*Report of the State Geologist, Henry H. Eames, on the metalliferous region bordering on Lake Superior. St. Paul, 1866.

†Mr. Kloos has fallen into an error in respect to both Owen and Hall. Owen's assistant, Shumard, ascended the Minnesota valley as far as the mouth of the Redwood river, instead of the mouth of the Cottonwood; while Hall only went as far west as Lake Shetek, instead of to the Pipestone quarry. (N. H. W.)

‡Notes upon the Geology of some portions of Minnesota, from St. Paul to the western part of the State. By James Hall, Trans. Am. Phil. Soc. vol. XIII, p. 329.

To the geographer, therefore, Minnesota possesses a great intrest, inasmuch as within its borders are found the spring-sources of the great rivers of the American continent. It lies to the north, in the least accessible portion of the United States. Upon the accompanying map of Minnesota can be seen two small lakes, distant but a few miles from each other, known as Itasca and Elbow lakes. In lake Itasca the Mississippi river has its source, and in Elbow lake the Red river of the North. The former flows, as is known, in a southerly direction to the Gulf of Mexico; the other turns with a sharp angle toward the north, unites in the great lake Winnipeg with the waters of the Saskatchewan coming from the Rocky Mountains, and empties with them through the Nelson river into Hudson's Bay. Lastly, the St. Louis and the Rainy lake rivers form the beginning of the extensive fresh-water system which comprises the chain of great lakes, and empties its waters in the Atlantic through the St. Lawrence.†

In Minnesota the banks of the Mississippi and its tributaries, together with the rocky shores of lake Superior, with its many short water courses, and the small lakes in the extreme northern part of the state, afford the only information concerning the age and composition of the earth's crust. As soon as one leaves the river valleys, he finds the older formations covered with heavy rolling hills of sand or clay without organic remains. These later deposits, which form a covering unbroken, except by the river valleys, are a part of the "Drift Formation," of North America. Over an extensive part of this territory it is spread out over the oldest crystalline rocks and on the sedimentary formations, and it extends south to the fortieth degree of north latitude. Even of the drift, in many parts of the state, can an idea of the composition and nature be ascertained only along the separate water-courses, because for days together one can travel without getting sight of a rock or of a hill. Either the grassy, boundless, prairies stretch out in all directions so that the eye cannot discern any tree or shrub, or vast forests, with successive meadows and lakes, cover the country. In the northern part of the state are many impenetrable cedar swamps, and through there it is only possible to pass in winter, when the swamps are frozen.

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*Wherever in this work miles are mentioned, the English Statute miles must be understood, of which 4.61 make a geographic mile.

†Mr. Kloss here loosely refers to the northern waters of the state. In reality the Rainy Lake river does not flow east into lake Superior, but westward into lake Winnipeg. [N. H. W.]

The sand and clay deposits of the drift formation are so thick that the smaller water-falls, the brooks and the rivers which have little descent, afford no additions to the outcropping rock. In southern Minnesota are cuts along the railroads from fifty to a hundred feet deep in which the bluffs show nothing but sand, loam and clay, without any organic remains. The drift forms sometimes a hilly, heavy deposit or extensive terrain, and sometimes a smooth horizontal surface as level as the sea. The depressions and valleys between the hills are generally filled with water, and thus are formed a numberless multitude of smaller and larger lakes. Their shores generally descend gradually, and show in the water-worn masses which gather there, the most varied kinds of crystalline rocks and metamorphic schists. Many swampy spots, both in the forest and on the prairie, are dried up lakes. By further draining these make excellent pasture grounds. The low grounds filled with water in the surface of the drift, are the remains of a single extensive fresh-water lake. In many places can be seen the remains of this old lake deposit. They consist of clay and loam with the same fresh-water mussel and snail shells as live at the present time in lakes and rivers. The southern shore of this lake lies probably not far from the Iowa boundary, where the highest ridges of the plateau are found. At Rochester and Mankato, points south of the Minnesota river, have been found trunks and branches of various kinds of trees, especially oak and cedar, in hills consisting of clay, twenty to fifty feet under the surface, and nine hundred and forty feet above the ocean level. These are all evident proofs that these ridges have once been the swampy shores of an ancient fresh-water basin.

The plains of Minnesota have a hight from 800 to 1,200 feet above the sea-level. The hill-ranges which run in various directions and form the water divides between the rivers and river-systems, reach in some places the hight of 1600 and 1700 feet. These are at the same time also the highest land of the country, and actual mountain ranges of rock do not exist.* The passage from the low lands to the water sheds is for the most part imperceptible, and the undulations of the plains, with the exception of the shores of the great rivers, take place altogether gradually. The highest water-shed lies in the northern part of the state, and separates the waters which flow south through the Mississippi valley, from those which have a northerly direction toward Hudson's bay. It is composed, through its whole extent, of drift; also theother divides, and greater elevations of the surface, consist of sand, loam and clay, and it is in the lower grounds and river valleys that one must seek for the older layers of the earth's crust. The shores of the Mississippi, with the range of bluffs lying nearest, consist of rocks which belong to the oldest portions of the Silurian formation. They are sandstones and dolomitic limestones which correspond to the Potsdam and Calciferous Sandstone, as well as the Trenton period, in the state of New York and in Canada. The layers are in all places nearly horizontal; but where the river has excavated the sandstone, and undermined the limestone beds, the latter are thrown down, and in many places over large areas, have apparently suffered an extensive denudation. The formations mentioned are in outcrop from the mouth of the Wisconsin river to the Falls of St. Anthony, over an extent of 210 miles. At the Wisconsin river the higher layers of the Silurian disappear, and there remain only the equivalents of the Potsdam and Calciferous sandrock, from there to St. Paul. The beds have at first a gentle southerly dip, which they maintain to Mountain Island, in the neighborhood of the city of Winona. Here is the highest part of a saddle-shaped elevation, and from there the layers have a dip, though almost imperceptible, toward the north. The elevation and depression in the hight of the separate layers make it possible to establish these conditions most clearly, as has been set forth in several profiles by Owen in an admirable manner. I had the opportunity to examine somewhat carefully the layers in the heighborhood of this saddle. The first line of bluffs rises precipitously to the hight of five or six hundred feet above the floodplain, and shows the outcroping of beds which after considerable interruption have their continuance on the opposite shore. The lowest is a sandrock, and over it are beds of dolomite. The former, which occupies the greater part of the rock-bluff, exhibits a different texture in different places. Some beds are coarse-grained, and approach a conglomerate, and others are very fine-grained. It is in general loose and crumbling with lime-cement. The dolomite, which here may reach a thickness of ninety feet, is of a light color, vesicular-crystalline, and resembles the German *Zechstein-dolomit.* It incloses many calc-spar and flinty concretions, which often attain a considerable size. I could discover no distinct fossils Only in one place did I find a fragment of a coiled cephalopod, which must have been of considerable size. Afterwards I found the same sandstone on the St. Croix river where some of the layers are very rich in bivalves, and I shall mention later their occurrence in describing the same rock again in the neighborhood of Taylor's Falls. The sandstone Owen has named *Lower Silurian sandstone of the upper Mississippi*, and the dolomite he distinguishes as the *Lower Magnesian limestone.* The former answers to the *Potsdam Sandstone,* and the latter to the *Calciferous Sandstone,* of New .York. The characteristic fossils are trilobites, which for the most part belong to the genus *Dikelocephalus*, also *Lingula* and *Orbicula.* In Minnesota it is difficult to find any large fragments of trilobites in the crumbling sandstone. Relying on observations made in Wisconsin, Owen distinguishes in this sandstone six trilobite-beds, which are separated from each other by other beds from ten to a hundred and fifty feet thick. In the magnesian limestone have been found up to this time only inconsiderable, and hardly recognizable, remains of fossils. They are a small *Lingula,* casts of the interior of shells which are related to *Euomphalus* and *Ophileta,* also fragments of trilobites like those in the sandstone. The geological horizon, therefore, of the lower dolomite must be determined at present from its position between the Potsdam Sandstone and layers of the Trenton formation.

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*According to published elevations, the hight of lake Superior at its low stage is taken at 600 feet. The latest measurements give an average hight of 606 feet) The Water-level varies in different years, and changes even with the seasons.

Before reaching the mouth of the St. Croix river above which both banks of the Mississippi belong to Minnesota, the lower sandstone disappears, and the shores, which have a hight of 200 or 300 feet, consis entirely of dolomite, which exhibits most remarkable water-worn forms, and presents many changes in its outer contour. The bluffs frequently pass back from the water, and the banks become lower. At Red rock, six miles below St. Paul, the hills are half a mile back from the river, while the shores rise but a few feet above the water level, and form a plain which is fertile but exposed to frequent inundations. Small exposures of the dolomite are still to be seen. The bluffs consist almost entirely of the next higher layers, the equivalents of the Trenton formation. At St. Paul the same rocks outcrop by the river, and form a rugged rock bluff from 90 to 100 feet high. From here the Trenton group continues, till, above the falls of St. Anthony, all the layers disappear together under a heavy covering of drift.

At St. Paul the bluffs have a thickness of 65 feet of sandstone, covered by 15 to 25 feet of heavy limestone layers, a repetition, therefore, to a certain extent of the bluffs below. Yet the sandstone hardly deserves this name, in that a cementing material is entirely wanting, and the rock can be dug into as easily as a sand bank. Indeed it is nothing but a vast bed of quartz grains that hardly hang together, in some places, of unusual clearness and transparency. For this reason it has been recommended by Shumard, one of Owen's assistants, for the manufacture of glass. The shining white walls of this sand rise perpendicularly from the water, and reach at Fort Snelling, an old fortification against the Indians, at the mouth of the St. Peter river, its greatest height. From here to St. Anthony the height, as well as the thickness, of the sandstone gradually diminishes. I have never yet succeeded in finding any fossils in this sand, and Owen regards it as entirely destitute of fossil remains. As it everywhere appears in close connection with the overlying limestone beds, which contain a great number of fossils characteristic of the Trenton of New York and the Llandeilo Flags of England, it must for that reason be placed with them in the same group, and is regarded by American geologists as the western equivalent of the Chazy limestone.

It seems at first a remarkable circumstance that so old a sandstone, covered by limestone beds, should possess so little firmness, but on examining carefully the stratification, a shale bed is discovered between the limestone and the sandrock, by which a supply of limy cement must be entirely cut off. Indeed in the upper part of the sandstone are shaly layers, and they attain, under the limestone, a thickness of one and a half to two feet. The shale has a dull blue color, efferœsces with acids, on being dried falls away in long shaly fragments, and is converted to a thick paste when exposed to the influence of water and air.

Concerning the stratification of the Trenton, as it is displayed on the upper Mississippi, I shall speak in a later work.* The cities of St. Paul, Minneapolis and St. Anthony are built upon the same rock-beds, and in St. Paul especially are found numerous outcrops. The limestones are clayey or dolomitic. The middle portion, which is the greatest, furnishes a very good building material, of which the stone structures of the cities mentioned are built. The best known fossils are:

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*The layers of the Trenton have had formerly a much greater extent. In southeastern Minnesota are many isolated patches of limestone and of the St. Peter sandstone yet to be brought to light and described. The fine sand which has so great an extent in the banks of the St. Peter river is derived from the weathered and scattered debris of sandrock.

Orthis tricenaria. Conrad.
Orthis testudinaria. Dalm.
Leptaena sericea. Sow.
A smooth *Pentamerus* and a *Strophomena.*
Murchisonia bicincta.
Bellerophon bilobatus. Sow.

All characteristic shells of the Trenton, and partly also of the Llandeilo Flags of England.

In the higher layers are added corals and brachiopods as well as a trilobite, which are not seen in the lower layers. They are for the most part the following:

Rhynchonella recurvirostra. Hall.
Rhynchonella increbescens. Hall.
Petraia corniculum. Hall.
Stenopora fibrosa. Goldf.
Calymene senaria. (*Blumenbachii.*)
Ptilodictya sp.—

fossils which altogether have been assigned to the Trenton by Logan in Canada.

Six miles above St. Paul the Minnesota or St. Peter's river empties into the Mississippi, having its source in a lake on the boundary line of Dakota. In its banks the lower beds of the Silurian again outcrop. Still its banks remain much lower than those of the Mississippi, and the lower sandstone nowhere reaches a greater thickness than 35 feet above the water.*

Between Minneapolis and St. Anthony, which lie opposite each other, the Mississippi forms at the present time a water-fall which, in a manner similar to Niagara, only at a greater rate, is kept in constant recession. The white sandstone, or rather the sand bank, is exposed unceasingly to the influence of the falling water. It is washed out, and the overlying limestone beds are broken off in great sheets which fall down. This process can be observed everywhere in the neighborhood of the falls In the midst of the river-channel lie the limestone masses scattered here and there in wild confusion. The falls are now but twenty feet high, yet must have had formerly, when the water plunged from the limestone beds, further down the river, a much greater height. Plans have been sought for to keep the falls in the same place by means of dams, canals and locks, since both St. Anthony and Minneapolis are manufacturing cities, and the timber from the northern part of the State is here sawed in a large number of mills.

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*The "Lower Sandstone" here referred to is the Jordan sandstone, and is not the "Lower Sandstone" seen in the Mississippi bluffs. [N. H W.]

Every little stream that enters the Mississippi over its high bluffs exhibits in a small way the same phenomena. Hence arise a number of smaller very picturesque water-falls, which are met with in the neighborhood of both the cities mentioned, among which Minnehaha (Laughing-water) is best known.

The Trenton limestone is the youngest member of the Silurian formation that I have as yet been able to find in the banks of the Mississippi.* In southern Minnesota it seems also that the equivalents of the Hudson river and Clinton formations are found. During the writing of this sketch I have seen in an American teacher's monthly journal a little treatise on the geology of southern Minnesota, in which the author mentions in the banks of Root river, a tributary of the Mississippi, a hundred and forty feet of beds of shale and shaly layers overlying the Trenton limestone, and covered by still other beds of sandstone with a thickness of a hundred and fifty feet.† Still I have not been able to learn anything in detail concerning these layers; and inasmuch as no fossils from these beds were mentioned their age still remains questionable, although it is not unlikely that the younger members of the Silurian pass from northern Iowa to this side of the Minnesota boundary. I have exhibited the boundaries of the Upper Silurian and Devonian in southeastern Minnesota on the accompanying plate, according to the representation of Mr. Hurlbut.

Above St. Anthony the older formations are covered by sand and drift for a distance of sixty miles, and the banks of the Mississippi show no outcrops. A few miles below the city of St. Cloud the area of the crystalline rocks begins. The stratigraphical relations of the sedimentary formations in respect to these outcrops of granitic rocks unfortunately cannot be ascertained. The most southerly point at which I found the granitic rock was on the Sauk river, one of the important tributaries of the Mississippi river in this region. Also between these rivers low outcrops of granite rock suddenly appear in the midst of the forest. In the banks of the Mississippi itself no outcrops of granite are known so far south. The strike of the crystalline rock seems, for that reason, to run in a north northeasterly direction. It forms low hills, and flat, or somewhat rounded, knolls, which rise sud-

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*The Hudson River beds can be seen at St. Paul, with a thickness of about 100 feet. [N. H. W.]

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†W. D. Hurlbut, in the Minnesota Teacher, February, 1871.

denly above the swampy plains. The Mississippi continues twenty miles in this way—toward the north then it enters on a belt of metamorphic schists of about the same width, of which I only had information of a mica-schist containing a great number of beautiful staurolite crystals.

The crystalline rocks of the Upper Mississippi show a great difference in their structure. They consist, for the most part of hornblende, orthoclase, oligoclase and mica. Quartz, indeed, is generally also present, though often in very small amount. Real granites, disregarding several fine granite-porphyries, are apparently rare, as well as real syenites. These rocks are in many respects interesting and I am preparing a more special work on the subject. The syenite-granites, as I shall provisionally designate them, show numerous changes from hornblende to mica. Many parts are hornblendic on the borders, and others are completely covered over with mica scales. The hornblende is greenish-black, lustrous or earthy, the mica dark-brown, and very glistening.

Quarries have lately been opened in different rocks of this range; they are to be used as building-stone, which, till now, has been confined to the bluish dolomitic limestone of St. Paul and St. Anthony. At St. Cloud a rock has been opened, which shows uniformly a clear-blue color which is derived from the bluish-white, translucent, feldspar. The United States Custom House, in St. Paul, is now partly built of it, and it has also been used a little in smaller buildings. At Sauk Rapids is a similar rock, bearing less quartz and more hornblende, used in the construction of a dam, and for bridge-piers. Further north has been opened for several months a quarry in a very fine decided granite. The greatly predominating orthoclase has, in fresh condition, a glistening white color. Next to that in amount comes the quartz, in grayish grains, and then black mica. This rock is also known as "Watab white granite," and, as soon as the railroad which now only reaches as far as Sauk Rapids, is extended further, will be largely transported to Chicago and St. Louis for large buildings.

In the whole Mississipi valley, from New Orleans to St. Cloud, no crystalline rocks are found, and it has been necessary to use, until now, limestone and sandstone, of rather inferior quality, as material for building. The quarrying of these granite rocks on the upper Mississippi promises for Minnesota in the future to become an important industry.

In a south south-westerly direction appears a similar region of crystalline rocks, exposed on the Minnesota river, where Owen observed granite and syenitic rocks over an extent of 45 miles, between the Cottonwood and Redwood rivers. The region between these points furnishes no outcrops. It consists partly of rolling prairie, and has many lakes on the shores of which water-worn drift-boulders are heaped up. The drift here is very thick; and as the leveling for the building of the Pacific railroad has been carried over it, it is found to constitute a high plateau between the Sauk and Minnesota rivers.

While on one side the hight of the first plateau at the Mississippi reaches 750 to 800 feet above the sea level, and lake Traverse on the Dakota boundary on the other side lies 825 feet above the sea, the line of divide through this high plateau, in the strike of the granite range, is from 1,100 to 1,250 feet above the sea.

According to Whittlesey who has passed repeatedly over the region, there is a connection between the granites of the upper Mississippi and those of the Minnesota. He even goes further, and continues the range northeastwardly along the watershed north of lake Superior. The crystalline rocks observed by him on the upper course of the Rum river, south of Mille Lacs lake, lie in the same prolongation. The slight elevation of the ridges and the thickness of the drift, make it, nevertheless, as yet impossible to demonstrate the connection.

Also Norwood, on the map of the geological survey, in the atlas to Owen's report, extends the line of the crystalline rocks from the upper Mississippi to the Minnesota river. Further, he unites it with the area of granite and crystalline schists in the extreme northern part of the state, which apparently correspond in age and composition to the Laurentian system of Canada. Prof. Hall says that the rocks in the neighborhood of the Redwood river have a gneissic character, and belong to the laurentian system. The metamorphosed sandstones and quartzyte which outcrop in the region and are extended widely over southwestern Minnesota, he places in the Huronian. The relations which these systems sustain to each other are at present not yet ascertained.

Yet all the present indications are that a wide zone of Laurentian rocks goes diagonally through Minnesota, and is accompanied on both sides by Huronian rocks. Until now, the latter were known only to the north of lake Superior. Their presence, however, in southern Minnesota, Prof. Hall has called attention to, where he has also assigned the celebrated "Pipestone Quarry" to the same age. As I shall show in the course of this work, the roofing slates on the St. Louis river must also be reckoned in the Huronian formation.

The interval between the Mississippi and the Red river of the North, amounts to 120 miles. Over this whole extent no outcropping rock has been known with certainty. It is nevertheless probable that the regular succession of Silurian rocks which are displayed on the east of the granites and crystalline schists, returns again on the west. Besides, Owen mentions a spot on the Red river in the neighborhood of the present town of Breckenridge where the Lower Silurian limestone is exposed.* As far as my knowledge goes, this is at the present time the only spot on the Red river, this side the international boundary, where an outcropping rock has been observed. Waterworn pieces of Silurian limestone are, however, of very frequent occurrence in the drift of the Red river valley. Whittlesey mentions Potsdam Sandstone at the falls of Pokegama on the Mississippi in north latitude 47° 15′, northwest of the Laurentian belt. This observation had, indeed, also been made by Owen, and this seems to be the reason why Norwood extends the oldest members of the Silurian on his chart to this place.

A very interesting portion of Minnesota to the geologist, is the eastern; viz.: the shores of lake Superior and the bluffs of the St. Louis and St. Croix rivers. The St. Croix valley which forms the boundary line of Wisconsin, lies, for the most part, in the lowest beds of the Silurian. The principal fossils of the Potsdam Sandstone, and of the lower dolomite are found in this valley. The greatest thickness of this sandstone above the water reaches 170 feet; also the dolomite here reaches the thickness of 100 feet. The beds are apparently horizontal, but in general they have a gentle dip toward the south.¶ Forty-five miles above its mouth the river is contracted, and suddenly its banks take on a different character. In place of the regular contour lines of the sandstone, are rough jagged rocks which outcrop close by the water. Here one stands on the rocks of the celebrated and picturesque "Dalles" or *Felsenhallen* of the St. Croix. The rock has been named by American geologists "porphyritic trap," and it resembles the Norwegian porphyry, which can be seen at Bogstadt on the west side of the Christiana Fiord. Several beds of this rock are cut through by the river, and alternate in the banks with the layers of the Potsdam Sandstone. As yet, I have had the opportunity only to examine this interesting rock over a small area in the neighborhood of the town of Taylor's Falls, near the falls of the St. Croix. Here it is exhibited as a beautiful, quartzless porphyry, or porphyryte, and constitutes the shores of the river and the hill-ranges.

I reached the river from the west side. After I had traveled for hours from St. Paul over the beautiful prairie, suddenly the deep and widely cut valley presented itself right before me. It was a surprising sight. With the greatest regularity of hight, lay several terraces above each other, and with the same hight they were visible also along the opposite bluffs on the Wisconsin side. Taylor's Falls is built on the first terrace, at the foot of which the water boils over the rock crags with the noise of thunder. Right opposite lie the falling ruins of a town in Wisconsin named St. Croix Falls, which owes its hasty bloom and its short, ephemeral existence to the speculation of several enterprising Yankees. Taylor's Falls is what is called in the west, a *lumbering-town*, that is, a place where the lumbermen of the St. Croix buy provisions, and from which, every winter, the men depart for the pineries. The high hills which enclose the place consist of porphyry. Further down the river appears the Potsdam sandstone.

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*No one else has ever seen this outcrop of limestone.—[N. H. W.]

The river here does not cut through a single ridge of the crystalline rock, but several diagonal ridges of an area of porphyry. The rock has a pretty uniform character throughout its whole extent. The ground-mass is crypto-crystalline and has a dark-green color. Under the loop can be seen a dark, non-translucent mineral, which in many places is formed in fibrous particles [stangligen partien], and a translucent mineral having the color of olivine. The feldspar crystals, which vary from dark-brown to black, give the rock a characteristic spotted appearance. The feldspar shows very evident striation and twinning, and seems to be the same as that in the brown porphyry of lake Superior. I have found iron-pyrites only as an accessory portion. In several places the rock holds amygdules, the only material of which seems to be white translucent quartz.

The relation of the porphyry to the sandstone beds is interesting. Owen assumes that the latter have been broken through and cut by the trap, although, thereby neither their texture nor their horizontal position have been changed. I cannot confirm that view, but believe the relations of these rocks at Taylor's Falls must require that the porphyry is older than the sedimentary beds.*

Indeed, the layers of the sandstone, wholly undisturbed, as can be seen on both shores, demonstrate that. Furthermore, I observed on the right bank of the river, the rock-profile, seen in Fig. 1.

The sandstone beds here lie horizontal over the porphyry, and continue in this manner over an extended area. They contain a number of fossils which are very beautifully preserved, and prove, even as much as the texture of the sandrock, the insignificant influence of any later outbreak of plutonic rock. A better proof of the greater age of the porphyry was afforded me by a conglomerate which consists of nothing but large water-worn masses of the porphyry, the position of which is between the porphyry and the sandstone. This singular rock, which I saw only in one spot, but in a considerable thickness, descends from the porphyry down to the neighborhood of the sandstone. The water-worn masses, which occasionally reach a considerable size, lie immediately in contact with each other, and have but a slight cementing material between them. Still the rock is very hard, and plainly bedded. The rounded masses and the cementing material consist altogether of more or less decomposed porphyry. Unfortunately the spot where the conglomerate lies under the sandstone, is covered with vegetation. (See Fig. 2.)*

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*Mr Kloss is supported in this by Mr. Sweet, of the geological survey of Wisconsin. [N. H. W.]

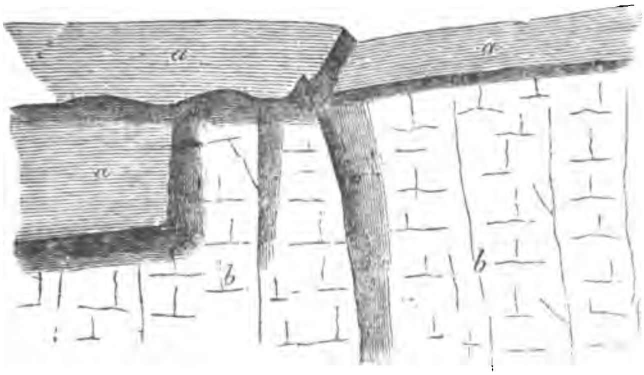

Fig. 1.

a a. Potsdam sandstone; the projecting beds which lie under the first river-terrace, on which Taylor's Falls is built. *b b*. Porphyry.

The character of the different beds which compose the sandstone at Taylor's Falls changes greatly in short intervals. The layers on the Minnesota side form a more continuous, projecting terrace than on the Wisconsin side, where, between the porphyry ranges, are several shallow or flat troughs. Going along the shore, I passed over several small hills, outrunners of the main hill range which forms a belt parallel with the river. Between these small hills lie the layers of sandstone, which descend on both sides level to the middle of the trough. If one ascends the main hill-range, nothing can be seen of the sandstone. How far the porphyry extends on each side from the river is unknown. In Minnesota, it disappears soon under the drift.

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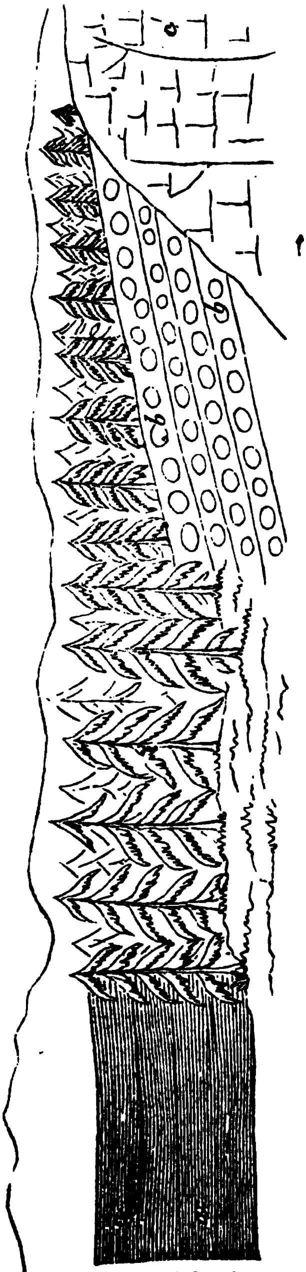
*Whittlesey mentions several spots in the neighborhood of lake Superior where the beds of the Potsdam sandstone lie upon the porphyry, both on the southern shore, at Keweenaw Point, in Wisconsin, and along the northern coast. But yet there can be no doubt that there is a porphyry and melaphyr o. the age of the Potsdam sandstone, the layers of which it broke through and upturned. It seems that the outflow of this quartzless porphyry began in Huronian time, and continued through the first part of the Silurian. The inclusion of the sandstone within the porphyry, mentioned by Owen, I have not been able to find at Taylor's Falls, though I have made dilligent search.

Fig. 2.



a a Sandstone; *b b* Conglomerate; *c* Porphyry.

In one of these troughs the rock consists of thin layers of dolomitic marl. It has a clear-gray color, a smooth, conchoidal fracture like limestone, and crumbles in the air, and at the same time it assumes a dazzling white color At the first glance one is apt to take it for a limestone; yet as it does not effervesce at all with acids, it must be principally dolomitic. Further up the river lie dark, iron-stained, firm crystalline layers of a sandy limestone; also the same in thin layers. At the same level on the Minnesota side is a clayey sandstone which does not effervesce with acids. It varies from fine to coarse grained. The latter prevails in the lower portion of the confused mass, and forms a high bank which rests immediately on the porphyry.

All these rocks carry the known species of *Lingula.* Those with the narrow extended beak (*L. antiqua*), and those which are shorter and wider (*L. prisca*) are very abundant, and completely fill some of the layers. Specimens of the former frequently reach five-eighths inch in length. Besides *Lingula* there are also species of *Orbicula* and *Obolus*, and trilobite shields as large as peas (*Conocephalites minutus?*). The shells seem to be distributed in certain belts in the layers; especially is this the case in the coarse, conglomeritic sandstone.*

The varied composition of the beds in their general relations is remarkable. It is true a simple layering one over the other can be seen; on the other hand they all seem to

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*The large wedge-shaped *Lingula* Owen has described as a new species, naming it *L. pinnæformis*, on account of its resemblance to a *pinna*. Nevertheless his illustration of it cannot be distinguished from *L. antiqua*. and in his description he does not bring forward the difference between it and the older species. Another peculiar species which Owen cites from the Taylor's Falls beds is the *Orbicula prima*. a very well defined shell, but which still may be identical with species of *Orbicula* described before from other places. I have no opportunity here to investigate the specific differences, and I shall return to it again later.

occupy the same level; both sandstone and dolomitic shale outcrop opposite each other in the banks of the river at the same hight, and they vary but little from the horizontal.

In order to obtain an examination of the relations of the sedimentary beds to the porphyry and melaphyr-like rocks of the north shore of Lake Superior, I made a trip the past fall to the west end of that lake. The railroad which connects St. Paul with this great American lake was completed the first of August of the former year. An iron track of 155 miles now connects the end of navigation from the Atlantic Ocean with the head of navigation of the Mississippi. Till within a short time it was very difficult to travel from there to the head of Lake Superior—now one rides there in a few hours. The commencement of the autumn storms made it impossible to carry out my plan, and I was compelled to confine my observations to the St. Louis river and the immediate neighborhood of the railroad.

Except a few cuts in the Trenton limestone in the suburbs of St. Paul, the tract of country crossed by the Lake Superior road affords no outcrops of rock till one reaches the valley of the St. Louis river. A vast forest, for the greater part consisting of pine, covers over the whole region. The land is generally flat and swampy. The railroad surveys have established the highest point at 567 feet above Lake Superior, or 1,167 feet above the ocean. This point is 120 miles from St. Paul and 35 miles from the lake. On all sides the plateau is flat, descending gently in both directions.

The first outcropping rock appears in low ridges in the midst of a cedar swamp near the St. Louis river, and at this place occurs the first opportunity since leaving the Mississippi, to behold the bedded rocks.* From here to the lake there is much rock, which offers an extended and little explored field for geological studies. During my short visit I could only make obeervations at a few points. The region is for the most part difficult to travel over. Extensive forests and swamps conceal the rock from view. There are no roads—even between the different stations and new places on the railroad it is necessary to travel on the railroad itself. When the rivers and streams are no longer passable for canoes, it is necessary to scramble from rock to rock in order to be able to look at the neighboring country. A slippery red clay forms the surface covering, wherever the black soil is torn up. Wherever the trees have been cut and the brush burnt, wherever roads have begun to be laid out, it is entirely impossible to travel after the occurrence of a few showers of rain. The whole region bears, more than any other in Minnesota, the stamp of wildness and primitiveness. It has been asked, what can be made of it. It will require immense resources and great labor to make it habitable and productive.

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*The bedded rocks, however, also appear in outcrop at White Bear Lake, at Hinckley and at Moose Lake. [N. H. W.]

The St. Louis river comes from the north, from a region of granite gneiss and mica schist about Vermilion lake, and turns, just before its waters reach Lake Superior, with a sharp angle to the east. Here the railroad company has constructed a high bridge over the river, and a new town is established which has been named Thompson, from one of the officers of the company. The water has broken through the steepey tilted beds, and here forms a long succession of falls and rapids, which in a few miles produce a descent of 370 feet, and are known as the *Rapids of the St. Louis River*. The valley is narrow and shut in by high picturesque cliffs. A dark fir-tree forest covers the hills about —indeed no region of America has reminded me so forcibly of the valleys of the Hartz mountains, and especially of the Bode and a part of the Okerthales.

The rocks also are similar to the rocks of the Hartz. The various strata consist alternately of dark-blue crystalline layers, frequently in the form of roofing slates, and a light firm sandrock or quartzyte which looks like many German graywacke sandstones.*

There has been formed a company for the manufacture of the roofing slates. Two quarries have been opened which promise good results. The slate is carried to St. Paul by the railroad; and this may become in the future a profitable industry. Norwood also mentions other slates on the St. Louis which are of a talcose and chloritic nature. Since they are found further up the river, they are in age earlier than the roofing slates. He has also noted a steep dip in the layers in opposite directions, which he ascribed to the injection of igneous rocks. But these he did not find. I also found no crystalline rocks, and I am not of the opinion that at the falls of the St. Louis river any local cause appears that produced the disturbance of the layers. So far as known to me the bedded rocks of northern Minnesota which are older than the Silurian, have been upheaved in the same manner. The beds are broken in a jagged form, and stand out boldly in little rock-islands in the very channel of the river, by which the quartzyte and slaty layers are always easy to distinguish, because the former constitute the elevated parts and the latter the troughs of the outcropping layers, as they are eroded and excavated by the water. No fossils have yet been found in these beds. The inclusions consist of little sulphur nodules. The principal quartzyte beds are penetrated by veins which are composed of quartz and calc-spar. Lines of feldspar are also of frequent occurrence in the slates.

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*This quartzyte seems to have been taken for greenstone both by Norwood and Eames.

Probably this whole formation belongs to the Huronian system which on Lake Huron and in the upper Peninsula of Michigan, appears between the Laurentian system and the lower Silurian. The position here exactly corresponds to that horizon. Credner in his work* on the pre-Silurian formations of the Upper Peninsula of Michigan, regards as a member of the Huronian a series of clay-slates and quartzyte beds of which the description applies equally well to these rocks. Chloritic slates constitute there as here a portion of the formation. The Potsdam Sandstone lies upon the outcropping beds in Michigan in the same manner as it can be seen to do on these beds further down the river at Fond du Lac. I have not examined this point myself, but quote Norwood's report, as to the facts, as follows: "Not far from the village of Fond du Lac the clay slates and chloritic slates are lost under the conglomerates and red sandstones of Lake Superior, the lower part of the Potsdam system. The latter lie upon the outcropping edges of the slates, with an inclination of six or seven degrees, but dip in the same direction." The place where the two systems lie unconformable to each other does not exceed three miles from the railroad bridge at Thompson, according to the statements of Norwood. From the position of the clay slates, one can infer the presence of the iron-bearing beds which in Michigan characterize the lower part of the Huronian. Perhaps these are the iron beds at Vermilion lake, in the neighborhood of which the metamorphic layers of the Laurentian begin.

Only at one place is the red sandstone to be seen near the railroad in the neighborhood of Lake Superior. This can not be far from the spot where this rock, in connection with the coarse conglomerate, lies unconformably upon the Huronian. The beds here lie nearly horizontal, with a slight inclination toward the south. The upper cuts of the railroad are in red clay before mentioned which, with varying beds of shale, sand and gravel, covers the older formations north and south from the great lake. It embraces a great extent of territory, reaches the height of 600 or 700 feet above the water level, and fills the valleys intervening between the ridges of the clay slates and quartzytes.

At the end of the railroad, where at the present time the streets of the new city of Duluth are being laid out on a steep hillside with an outlay of unprecedented expense, are large exposures of different kinds of crystalline rocks. These form the shores on the left of St. Louis Bay and of the Bay of Superior. The former consists of a widening of the mouth of the river, the latter of a part of the lake shut in by a narrow strip of land, forming a fine harbor. The conformation of the west end of Lake Superior is in the highest degree remarkable. Two small tongues of land project parallel with each from the shore, and are met by narrow points extended in the same way from the Wisconsin shore. Narrow channels or passes only are left so as to admit to the waters enclosed between them. The outermost of these strips of land, Minnesota Point, is six miles long, and has a mean width of only 600 feet. It consists of beach-worn material, or shingle, and it rises but few feet above the level of the water. These pieces have an oblong, generally flattened form, and consist for the most part, of melaphyr, porphyry, and amygdaloid with calc-spar geodes, both large and small.

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*This Journal, 1869, p. 528.

Connor's Point in Wisconsin and Rice's Point in Minnesota separate the Bay of St. Louis from Superior Bay. Between them is a channel affording fifty feet depth of water, through which the waters of the St. Louis reach the lake. Superior Bay has its greatest depth near Minnesota Point. Along the opposite shore in Wisconsin it was necessary to build out more than a hundred feet into the bay to find nine feet of water, while on the Minnesota side the water had a depth of 15 to 18 feet. A street from Duluth extends now along Minnesota Point, and the railroad company have begun to cut through it in the neighborhood of the place where it is joined to the mainland, for the purpose of making a fine harbor, sheltered by this natural breakwater. The natural approach, six miles further south, is exposed to much drifting sand, and has also been worked by the people of Wisconsin in order to improve it for an entrance.

In the vicinity of Duluth I have observed three different kinds of rock, but nowhere could I make out the connection which they have to each other. The first, which rises from under the red drift clay and is finely exposed in the vicinity of the railroad depot, the Americans style "granite," to which, however, it has no resemblance. It consists principally of a feldspar of a dirty white color, which is in the form of fine large crystalline grains, which show three cleavage directions. Two of these stand almost at right angles to one another, one of which has a marked greasy luster, and the other a strong glassy luster with fine twinning-lines. The third cleavage direction is only made apparent by fractures which cut both of the others at acute angles, and seems to appear very rarely. I took the feldspar for labradorite. The second ingredient is a dark green to black mineral, of a greasy appearance, which it is difficult to distinguish, because the color is like that of the predominant feldspar. It is indistinctly fibrous, and I took it for diallage or hypersthene. A black, shining mineral, in irregularly shaped grains, which have a strong metallic luster, is sprinkled abundantly in this rock, and stands out beyond all the others on the surface of the weathered crust. On a fresh fracture of the rock it is hard and brittle. Yet under the action of the atmosphere it becomes softer, and then if it is scratched with a knife, small black particles of it remain attached to the blade. Before the blow pipe it behaves like pure magnetic iron. It disintegrates only after a long time, and very seldom is it seen to become oxidized on the outside and changed to a brown ochre. No trace of titanium was discovered.

For the most part this rock has a resemblance to gabbro, or hypersthenyte, although it shows in its whole extent a tolerably uniform structure, and generally a coarsely granular texture. In this rock a quarry has been opened, and the stone is being worked and polished for monumental purposes.

The second rock is cryptocrystalline to compact. In the black groundmass lie brightly glittering needles of feldspar with evident twinning striation. It is exactly like the rock from small veins in the syenite at Sauk Rapids on the Mississippi, and is to be considered, probably, with the greatest degree of exactness, until a more close examination can be made, as a black porphyry or melaphyr.

Next to this a beautiful porphyry forms the first rock at the shore of the lake. This rock is different from the porphyry of the St. Croix river, and in the main resembles the porphyry from Ilfeld in the Hartz. In fresh condition the groundmass is an exceedingly fine-grained mixture of a clear and a dark-brown mineral. The feldspar crystals appear only by reason of their luster, upon the commencement of disintegration of the rock, because of their presenting a somewhat brighter color. Magnetite is sparsely disseminated, and still more sparsely a little pistazite. But the latter mineral is very abundant in the seams, and veins of calc-spar with which the rock is very much intersected. In the same manner also laumontite occurs, and in fact as a pseudomorph after calc-spar. In company with this brown porphyry is found an amygdaloid with a somewhat decayed groundmass. The cavities, which are somewhat elongated, are filled with quartz, calc-spar, chlorite and a decayed iron-bearing mineral. The crystals of feldspar in the porphyry are also in process of decay. A regular variation or interchange between these two rocks is nowhere to be seen. On the other hand the undecayed massive porphyry goes over to the amygdaloid Apparently the decaying of the groundmass and the crystals has gone on step by step with the filling of the amygdaloidal cavities. As already remarked, I have observed the above described rocks nowhere in contact. The works in the city of Duluth will, however, soon furnish fine exposures. The beds of the Lower Silurian which appear further down on the Lake Superior shore, and upon the river, are not found at Duluth nor in the immediate vicinity. Similar reddish-brown porphyries appear to be very widely distributed on the north shore of Lake Superior. The lateness of the season prevented an excursion in a sail boat for observation along the coast. The above described crystalline rocks are grouped together by all American geologists under the name "trap." Whittlesey mentions an augitic, quartziferous and amygdaloidal trap. In other places he speaks of a brown, decayed trap, and of a firm trap, both cut through by dykes of basalt, without giving any further definition of these different rocks.

The Potsdam sandstone forms the north shore of Lake Superior, as well as the south shore. The dip of the beds forms an anticlinal, and the lake consists of a basin of fresh water in the layers of the Lower Silurian. The breaking out of porphyries and melaphyrs, sometimes in the form of dykes and at other times alternating in layers with the sandstone, makes the geological relations very complicated. Along the north shore runs a range of hills which consist of metamorphic and plutonic rocks belonging to the Huronian formation. Five or six miles inland it attains its greatest hight of 600 to 1,000 feet above the level of the lake. Then this terrane is wanting, for the most part, along the coast, and the Silurian beds overlie the Huronian.

A number of streams have their sources in this hill-range, and often winding through the bedded and massive rocks, with rapid descent bear their waters to the lake. They give rise to many outcrops and lay bare the bedding and such like conditions of the melaphyr-masses. Several have attained a positive reputation for their promise of profitable mining of copper, and are valued highly for the future mining of this metal. This is especially the case at the French and Knife river districts.

Whittlesey says that the trappean rocks which bear metallic copper, are of the age of the Potsdam sandstone, and that those that contain the sulphuret ores belong to the Huronian formation.* Also that the cupriferous beds become barren when they change from trap to sandstone. I am still too little acquainted with the appearance of copper on the north shore of Lake Superior, to presume to have an opinion respecting those beds that may be valuable for mining, but I do not believe that the first of these statements has any general validity. I had opportunity to examine somewhat closely some fragments from a vein in a rock designated "trap," from the north shore. It was obtained from a bay between Encampment Island and Kinewabic river, and hence from the area occupied by the rocks of the Potsdam. This place is 30 miles from Duluth, and in the vicinity of Knife river. The rock has a resemblance to a bright, clay-slate, with many strings of calc-spar cutting it in all directions. The calc-spar is crystallized in veins. Its weight certainly indicated that it contained copper or iron. Upon a careful examination can be seen also a sulphide, and black specks of a substance having a metallic luster on the outside, finely scattered through the mass. The latter shows before the blowpipe, the reactions of a mixture of chalcopyrite and pyrite. It contained no native copper, and I could not discover in the wet way any trace of silver.

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*Whittlesey's report of 1866, p. 5.

The above mentioned rock is said to have a thickness of forty feet, and rises perpendicular from the shore, and can be followed inland a short distance. Only the smallest portion of this mass embraces those sulphides and metallic compounds. Similar exposures, showing a little metallic content, a layering and a network of a small mineral vein, are a frequent occurrence in these massive rocks, and point with certainty to a very general diffusion of copper. Yet it has not been found in sufficient quantity to support mining with profit. The best prospects are located at French river, in melaphyrs interbedded with sandstone.

Immediately after the conclusion of a treaty with the Indians in the year 1854, by the terms of which the north shore of Lake Superior was opened to the whites, agents of eastern capitalists explored the region for mineral deposits, Upon superficial observations of men who had but slight acquaintance either with geology or mining, large tracts here were set forth as mineral lands, and as such were disposed of by the government to companies and private individuals. In 1858 the land was surveyed, and many "claims," which had been made before were relinquished. A few years ago a company was formed in Buffalo which began to explore the regions of French and Knife rivers more carefully. A shaft was sunk to the depth of 48 feet, and a quantity of copper ore was found in the deeper lying beds. Nevertheless, these works are now suspended.

At different places on the St. Croix river and its tributaries, copper has been found. Especially is Taylor's Falls and that vicinity, as well as Kettle river, forty miles further north in Minnesota, regarded as a region which some time will be celebrated as a copper.producing district. What has been found thus far consists, in the first place, of large massive pieces in the river-bed, and in the water-worn material of the drift which covers the river banks, and secondly of veins and layers in the porphyry, which produce both metallic copper and copper-glance and copper-oxide, from a heavy but decayed gangue.

Massive, irregularly-shaped, but rounded pieces of native copper have been found in several places in the valleys of streams coming from the north. I saw at Taylor's Falls a heavy specimen weighing fifteen pounds, which was found in the digging of a well several feet below the surface, in the drift. These copper masses in every instance have been exposed for a considerable time to the action of water, and I do not believe that their place of origin should be considered as being in that vicinity. In this opinion I was afterward strengthened, since I found in the drift and gravel which lie on the St. Peter sandstone, as large and equally rounded a piece of metallic copper in the eastern part of the city of St. Paul. It is most probable that along with the drift, metallic copper is brought hither from the southern shores of Lake Superior.*

What I have seen of the copper-bearing rocks of Taylor's Falls, shows the presence of this metal in small quantities near the surface, affording, therefore, some expectation of profit on deep mining. I was conducted to two old shafts and several pits which some time before had been sunk on the summit of a range of porphyry. The shafts were filled with water to the top. The material lying about contained no native copper. It was a porphyry in process of decay, with veins of quartz and feldspar. A six-inch vein of feldspathic, decayed rock had given rise to the exploration The feldspar vein can be followed for a distance of several hundred feet, and, according to the statement of my companion, under whose instigation the work had been undertaken, had a thickness of two and one-half feet at the depth of twenty. The samples brought from this depth consist of a much changed feldespathic snd calcareous rock. Copper strikes through the mass in slender leaves and threads. Fine black threads, of a black metallic luster, were found to be copper-sulphide, before the blowpipe, and did not exhibit, in the wet way, any content of silver, so far as I could judge. A second place, which had been pointed out by the residents as an outcrop of a copper vein, is at the mouth of a creek which passes down the steep bluffs through the midst of the town. It was a sort of contact-vein between the porphyry and the sandstone. What I could see of the gang-mass in the neighborhood of the very imperfect exposure, consisted of an earthy, much changed amygdaloid. It was asserted to me that copper is to be found, although I saw in the amygdaloid itself not a trace; and I expect that it is one of the erratic pieces from the drift, which is disseminated in the bed of the creek between the larger blocks of porphyry.

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*Masses of metallic copper are found occasionally in the northern drift in Michigan, Wisconsin and Ohio.

Similar feldspar veins as those above mentioned are a very frequent appearance in the porphyry. They always have at the surface only a few inches thickness.

More promising appears the copper outcrop on Kettle river. In 1865 it was pronounced a true vein with a width of 22 feet by Prof. James Hall. I obtained several pieces of the gang. They consist, first, of a brownish dense melaphyr-amygdaloid without apparent crystals. The cavities are filled with quartz, calcite, epidote and copper. It is cut through by numberless fine slits which are filled with the same minerals. The copper is in threads, thin sheets, and also in net-work and knot-like forms, and is always accompanied by quartz, calcite and epidote. The color of the groundmass changes from brown to green, and several specimens approach the color of green, although more distinctly colored through. This is a bluish-green rock, with heavy groundmass, though without evident crystals still carrying the same cavities and amygdaloidal minerals.

A third rock is much changed, mainly feldspathic, but interspersed with a dark mineral. Its prevailing color is derived from copper-salts. The copper is metallic, and is desseminated in extremely fine threads through the whole mass. In this rock appear outcropping veins of copper-glance and earthy malachite. At least there are, among the material derived from this locality, two handsamples which show both these ores in the same groundmass.

The copper-bearing samples of rock from Kettle river, collectively, have the aspect and the characters of vein rocks.

How far the above described appearances may warrant the hope of profitable mining of copper, must be left undetermined till more exact investigations shall have established the extent, the range and the content of copper. The lands of Kettle river have been taken possession of by speculators, in the same manner as those of the north shore of Lake Superior some time before. Here and there examinations have been made in order to learn something of the particulars of the region, yet always in a hasty way and generally by people without sufficient geological knowledge.

From Vermilion lake I have become acquainted with gneisses and firmly crystalline clay slates with much interspersed pyrites, which apparently belong to the Laurentian system. A number of quartz veins cut through these metamorphic schists, which contain a little portion of copper pyrite. The pyrite has been shown to be gold-bearing. A short time ago arose a real *excitement*, of the American type, over Vermilion lake, because it was believed that here had been found a new gold field. There were formed in Chicago, New York, and other cities, several companies; and caravans with furnaces, stamp-works, and amalgamating mills, pressed forward into the wilderness. Large sums of money were soon sunk in Vermilion lake. The government itself laid out a road from Duluth, and the works were in progress till a short time since. Several shafts were dug, among others one 70 feet deep by a New York company. As yet the costs have far exceeded in amount the value of the small quantity of gold which has actually been taken out. I have seen a number of samples of the gold-bearing quartz of Vermilion lake, but have not yet found even a speck of native gold. Likewise I have not been able, in spite of the most diligent enquiry, to find any one who has seen it. There is now no doubt at all that so long as the region remains inhabited by Indians and fur-animals, separated seventy miles from any railroad, the amount of gold taken out cannot pay any one.

The same must be said of the iron ores outcropping in the neighborhood of Vermilion lake, concerning which the reports brought by travelers are very favorable; the profitable mining of which, nevertheless will not be entirely feasible without a railroad connection with Lake Superior. The description which Eames gives of these* agrees with the red iron-rocks of the Huronian on the south shore of Lake Superior in the State of Michigan·** The iron ores from Vermilion lake that have been brought to St Paul consist of a very pure, glittering haematite, of a steel-gray color.

It is probable that further search in Minnesota, on both sides of the zone of Laurentian rocks, will show the presence of Huronian iron ores. There have this year new surveys been made along the branch line of the Pacific railroad which runs along the Mississippi, extending further toward the north. I hope by this means to learn of interest-

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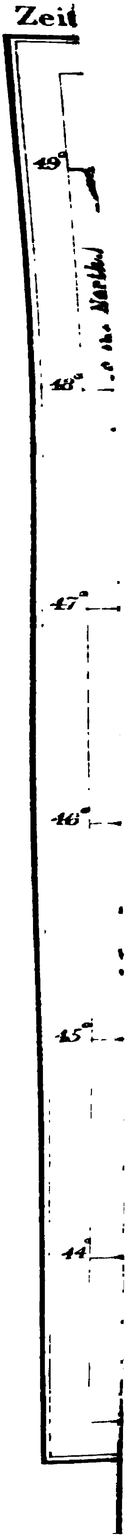
*Report of Henry Eames 1866, p. 11.

**Credner: *Zeitschr, d. Deutsch, geol. Ges.* 1869 s. 527.

ing facts concerning the relationships of the Laurentian, Huronian and Silurian rocks in the upper portion of the Mississippi valley.

Besides the rocks and formations described above, I have marked upon the plate (Taf. VIII.) a small area south from the St. Peter river lying between Laurentian and Huronian rocks. This small area belongs, according to the investigations of Prof. Hall, to the Cretaceous formation. It is an old fresh-water basin in which has been found a considerable quantity of brown coal. As I have not examined the region myself, and I know nothing further about it, I shall give here nothing further concerning its appearance. Much effort has been made continually to find stone coal, or brown coal, in Minnesota, because in a large part of the State there is a lack of forest, and therefore of fuel. The small Cretaceous area on the Cottonwood river is as yet the only spot where real coal-bearing beds have been found in outcrop. All former discoveries have proved to be "drift coal," or erratic pieces in the diluvium.


Zeit
49°
48°
47°
46°
45°
44°

VII.

CHEMISTRY.

ANALYSES BY PROF. JAMES A. DODGE.

Analyses have been reported by Prof. Dodge of substances for the survey, from Nos. 69 to 83, both inclusive, of the Chemical Series. This list is from the following localities:

No. 69. Efflorescence on the surface of the ground ("alkali"), Sec. 14, Iona, Murray Co. Mus. Reg. No. 3936.

No. 70. Light-colored pipestone, or "chalk-rock" so-called, Palisades, Minnehaha County, Dakota, two rods east of the dam, in the plane of the pipestone. Mus. Reg. No. 3896.

No. 71. Light blue calciferous sandrock, from the lower part of the quarry of Maxfield and Mather, Mankato, showing non-hydrated (unoxidized) natural condition of the deeper beds of the Shakopee formation.

No. 72. Rice Point granite, No. 1 of the Survey Series. To determine the alkalies and the lime of the feldspar.

No. 73. Rice Point red granite, No. 1 B, of the Survey Series. To determine the alkali of the feldspar.

No. 74. Limestone, supposed to be hydraulic the equivalent of the shale layer at Maxfield's quarry, at Mankato. From the quarry of J. R. Beatty & Co., near Mankato.

No. 75. Light-colored, nearly white clay, supposed to be kaolinic, from the same place as the above, but probably Cretaceous.

No. 76. Water from Mille Lacs, needing filtering.

No. 77. Water of the Mississippi river from above Minneapoli about one mile, right bank.

No. 78. Water of the Mississipi river from below Minneapolis about one mile, right bank.

No. 79. Limestone of the Hudson river Group at Clinton Falls, near Owatonna, quarry of Lindersmith & Son.

No. 80. Limy sediment in a layer in the till, on Nicollet Island, Minneapolis.

No. 81 Ore supposed to contain copper, from near Beaver Bay. From T. 56, R. 8, S. W. ¼ Sec. 22, on North river, Wieland Brothers.

No. 82. Lime City limestone, Filmore county. Mus. Reg. No. 4099.

No. 83. Concretionary Cretaceous. Two Rivers, Morrison county. Mus. Reg. No. 4561.

ANALYSES.

No. 69, Chemical Series. Museum Reg. No. 3936.

“*Alkali*” Efflorescence, with soil adhering.

Whole substance powdered, air-dried, digested with water:—

	Per cent.
Dissolved by water	48.6
The residue digested with hydrochloric acid:—	
Dissolved additional	3.1
Total dissolved matter of the whole substance	51.7

Portion dissolved by water contained:

MgO, 22.5 per cent. SO_3, 44 8 “	67.3 per cent. sulphate magnesia
Water	not determined
SiO_2, Fe_2O_3	traces
Organic matter	traces

The sulphate of magnesia was therefore not present in the form of Epsomite, as MgO, SO_3, $7H_2O$.

Would require MgO, 16.26 per cent. “ “ SO_3, 32.52 “	48.78 per cent.
“ “ $7H_2O$	51.22 “

Portion (additional,) dissolved by hydrochloric acid contained:

SiO_2	18.6 per cent.	
Fe_2O_3, Al_2O_3 and phosphoric acid	58.3 “	(mainly Fe_2O_3)
MgO	20.5 “	
CaO	traces	
Organic matter	“	
Alkalies	“	

The residue, insoluble in H Cl, fused with carbonate of soda, gave:

SiO_2	75.8
Al_2O_3	11.1
Fe_2O_3	2.1

CaO	.86
MgO	.66
Organic matter	considerable
Alkalies	trace

This residue was in fact simply a dark soil, with fragments of roots &c.

Carbonic acid, and chlorides were almost wholly absent from the substance. Potash and soda were present in slight traces. Lime also was present in slight traces.

No. 70, *Chemical Series*, Museum Reg. No. 3896.

SiO_2	50.4	per cent.
Al_2O_3	33.3	“
Fe_2O_3	2.8	“
CaO	0.6	“
MgO	0.17	“
Na_2O	3.5	“
K_2O	0.6	“
H_2O	9.6	“
	100.97	

The composition agrees fairly with that of Catlinite, which the rock resembles in physical properties except color, being white with tinge of yellow.

No. 71. Rock, a limestone of light-gray color, containing silica.

Ten grammes of the powered and dried mineral were digested with hydrochloric acid; a residue was left which weighed 1.552 gms., making 15.52 per cent. of the rock; the portion dissolved was therefore 84.48 per cent.

Analysis of portion dissolved by hydrochloric acid:—

Fe_2O_3 with small amount of Al_2O_3 and SiO_2	3.14	per cent.,	being	2.65	per cent.	of whole	rock.
$CaO\ CO_2$	55.47	“	“	46.86	“	“	“
$MgO\ CO_2$	39.73	“	“	33.56	“	“	“
	98.34			83.07			

Analysis of portion left undissolved by hydrochloric acid:—

SiO_2	-	77.9	per cent.,	being	12.1	per cent.	of. whole	rock.
Al_2O_3	-	19.24	“	“	2.99	“	“	“
CaO	-	.34	“	“	.05	“	“	“
MgO	-	.12	“	“	.02	“	“	“
Alkalies,		traces.						
Organic matter,		traces.						
		97.60			15.16			

It appears, therefore, that the rock is a magnesian limestone, with about 12 per cent. of silica and somewhat over 2½ per cent. of oxide of iron.

No. 72. A granitic rock of bluish-gray color, from which the feldspathic portion was selected (by mechanical means) as clean as possible. This portion, which was still, however, not wholly unmixed with other constituents of the rock, was analyzed with the following result:

SiO_2	49.78	per cent.
Al_2O_3 and Fe_2O_3*	32.36	"
CaO	11.55	"
MgO	1.43	"
K_2O	.41	"
Na_2O	3.39	"
H_2O	1.83	"
	100.76	

No. 73. A granitic rock of reddish color; this was analyzed as a whole, the grain being too fine to permit mechanical separation of its constituents.

SiO_2	75.78	per cent.
Al_2O_3	11.09	"
Fe_2O_3	2.09	"
CaO	.86	"
MgO	.65	"
K_2O	1.06	"
Na_2O	6.43	"
H_2O	1.82	"
	99.78	

No. 74. Rock a siliceous limestone. Digested with hydrochloric acid, a residue was left amounting to 19.67 per cent., the dissolved portion was therefore 80.33 per cent.

Analysis of portion dissolved by hydrochloric acid:—

SiO_2	.27	per cent.,	being	.21	per cent.	of whole	rock.
Al_2O_3	.15	"	"	.11	"	"	"
Fe_2O_3	3.03	"	"	2.43	"	"	"
$CaO\ CO_2$	55.62	"	"	44.68	"	"	"
$MgO\ CO_2$	39.13	"	"	31.59	"	"	"
	98.21			79.02			

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*Note.—The amount of oxide of iron is quite small.

Analysis of portion not dissolved by hydrochloric acid:—

SiO_2 -	78.27	per cent.,	being	15.29	per cent.	of whole	rock.
Al_2O_3 -	18.33	"	"	3.61	"	"	"
CaO -	.48	"	"	.09	"	"	"
MgO -	.23	"	"	.04	"	"	"
Alkalies -	traces.						
Organic matter	traces.						
	97.31			19.03			

A determination of water in the dried powder gave 4 per cent. (of whole rock.)

This is therefore a magnesian limestone, containing about 15 per cent. of silica, and but a moderate quantity of oxide of iron. It would appear likely to make a good hydraulic lime.. No. 71 might also serve that use.

No. 75. A very light-colored clay, from Mankato. This was pulverized, without grinding up the particles of gritty matter that were to some extent intermixed with it; the powder was then mixed with distilled water, the suspended portion poured off and allowed to settle for a day or two; the settled portion was then collected, dried at 212°, and submitted to analysis by the common methods for silicates.

SiO_2	87.7	per cent.
Al_2O_3	7.24	"
Fe_2O_3	traces	"
CaO	.67	"
MgO	.07	"
K_2O	.49	"
Na_2O	3.17	"
Organic matter	traces	
Water	traces	
	99.34	

No. 76, of the Chemical Series. As received this water showed some turbidity, and had deposited a brownish sediment in the can. It was filtered, and a large quantity evaporated. In the course of this evaporation a similar brown flocculent matter separated out. It consisted of organic matter mixed with oxide of iron.

The residue from evaporation was submitted to analysis, and found to consist of the following substances, in the amounts stated:

Silica............	3 85	per cent.	of total	residue from	evaporation.
Carb. lime.......	28.07	"	"	"	"
Sulph. lime.....	.95	"	"	"	"
Carb. Mag......	28.62	"	"	"	"
Oxide of iron....	1.26	"	"	"	"
Carb. potassa...	3.03	"	"	"	"
Carb soda......	11.09	"	"	"	"
Chl. sodium	.74	"	"	"	"
Organic matter..	22.40	"	"	"	"

The weight of the residue from a given quantity of water was found to be in the proportion of about 10 grains to the gallon. Reckoning the above specified constituents in grains per gallon, I found:—

Silica..................................	.2499	grains	per gallon
Carbonate of Lime........................	3.1355	"	"
Sulphate of Lime.........................	.1051	"	"
Carbonate of Magnesia....................	3.1589	"	"
Oxide of Iron............................	.1389	"	"
Carbonate of Potash......................	.3346	"	"
Carbonate of Soda........................	1.2241	"	"
Chloride of Sodium.......................	.0817	"	"
Total Mineral matter.................	8.4287	"	"
Organic matter...........................	2 4458	"	"
Total residue........................	10.8745	"	"

In regard to the above figures, it is to be noted, that the amount of solid residue taken as a whole is not great, compared with that from many waters in this State; that the amounts of lime and magnesia (existing in the water as bicarbonates,) are but moderate; that sulphates and chlorides are almost wanting, and that the water is *alkaline*, by virtue of the presence of the carbonate of potash and soda. Upon concentration of this water, in a platinum dish, a ready and decided test is obtained by litmus and turmeric papers.

Further, it was found that nitrates and phosphates are absent.

No special examination of the organic matter was made.

Nos. 77 and 78 of the Chemical Series.

MINNEAPOLIS, MINN., March 13, 1882.

Prof. N. H. Winchell:

DEAR SIR:—I hereby report the results of my analysis of the water of the river made at your request with a view to determine what difference might show itself in the water above and below the city. Two samples were procured, at the same time and in the same manner, the one (No. 77,) at a point on the west bank about half a mile above the upper bridge, (Plymouth Ave.,) and above all apparent considerable sources of contamination, the other (No. 78) at a point, also on the west bank, below the brewery, at the small grove near the Fair Grounds.

These two samples of the river water have been submitted to precisely the same course of analysis. A quantity of each sample, amounting to eight litres—somewhat over two gallons—was evaporated to dryness, and the composition of the residue ascertained. In addition, the method of determining organic matter in water by the distillation process of Wanklyn, was applied to each sample of water.

The samples of water were procured by me about the 20th of December. They were immediately filtered, and kept in suitable glass vessels; that part of the work of analysis which needed to be done without delay, in order to avoid the effects of change in the water by keeping, was done. The remainder has been carried on with other work during great part of the winter.

1. Composition of the residue from evaporation of the water of the river above Minneapolis:—

Silica. SiO_2	.78256	grains per gallon
Carbonate of Lime, $CaO\ CO_2$	6.39532	“ “
Carbonate of Magnesia MgO, CO_2	3.15307	“ “
Carbonate of Iron, $FeO\ CO_2$	.05504	“ “
Chloride of Sodium, $NaCl$	.16352	“ “
Potash, K_2O	.10162	“ “
Soda, Na_2O	.17462	“ “
Sulphuric Acid, SO_3	.16445	“ “
Nitric Acid, N_2O_5	traces	
Total Mineral matter in the residue	10.99020	“ “
Organic matter	1.40228	“ “
Total Min'l & Organic m't'r in residue	12.39248	“ “

2. Composition of the residue from evaporation of the water of the river below Minneapolis:—

Silica, SiO_2	.97090	grains per gallon
Carbonate of Lime, $CaO\ CO_2$	6.13722	“ “
Carbonate of Magnesia, $MgO\ CO_2$	2.42827	“ “
Carbonate of Iron, $FeO\ CO_2$	.15560	“ “

Chloride of Sodium, NaCl	.18408	"	"
Potash, K_2O	.15826	"	"
Soda, Na_2O	.15126	"	"
Sulphuric Acid, SO_3	.17462	"	"
Nitric Acid, N_2O_5	traces,more than in No.1		
Total Mineral matter in residue	10.36021	grains per gallon	
Organic matter	1.96219	"	"
Total Min'l & Organic m't'r in residue	12.32240	"	"

3. Results of Wanklyn's method for determining the organic matter, in water from above city:—

Free Ammonia,		.0175	milligrammes per litre,
	or	.0175	parts per million.
Albuminoid Amonia,		.0625	mgm. per litre,
	or	.0625	parts per million.

4. Results of Wanklyn's method for determining the organic matter, in water from below city:—

Free Ammonia,	.0266	parts per million.
Albuminoid Ammonia,	.1550	parts per million.

I would like to call attention to the following points: First, the amount of matter, mineral and organic together, differs but little, in the residues from the evaporation of the two waters; but the amount of organic matter in the water from below the city is appreciably larger than in the water from above; on the other hand the amonnt of mineral matter is larger in the water from above. This latter result was to me wholly unexpected, but I am certain of its correctness. The water of the river below contains a little less carb[illegible] of lime and magnesia than the water above. The difference, however, is wholly immaterial in a practical point of view, and may be accounted for by the influx of several creeks which bring in softer water than the river; also by the consideration that what lime finds its way into the river from factories and from masons' use, may serve to precipitate a small part of the carbonate of lime and magnesia that are in the river. Second, the difference in the amount of organic matter in the two samples, is quite material, in sanitary respects. The results of the determination of free ammonia and albuminoid ammonia are such as to place the water from above the city under the head of good drinking water, while that from below would be excluded from that class. It is to be observed that the water below shows somewhat more of all ingredients except lime and magnesia. In the case of nitrates, a quantitative determination could not be made. Qualitative tests showed somewhat more in the water below.

Very respectfully,
JAMES A. DODGE.

Chemical Series, No. 79, *a Siliceous Limestone.*

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Silica	2.88	Silica	10.74
Oxide of iron	2.56	Oxide of iron and alumina	.80
Calcium carbonate	58.09	Lime	traces
Magnesium carbonate	19.90	Magnesia	.63
Alkalies	traces	Alkalies	traces
Sulphric acid	traces	Organic matter	not determined
	83.43		15.17

Chemical Series No. 80.

Calcareous rock, with iron pyrites distributed through it, and having a vein mainly of pyrites.

Main rock:—	Vein:—
Assayed $\frac{1}{2}$ oz. gold $\frac{1}{10}$ oz. silver } per ton.	Assayed 1 oz. gold $\frac{1}{10}$ oz. silver } per ton.

Chemical Series No. 81, *Calcareous Layers in Drift, Nicollet Island.*

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Oxide of iron	2.69	Silica and silicates	35.53
Calcium carbonate	55.55		
Magnesium carbonate	4.95		
	63.19		

Chemical Series No. 82, *Limestone.*

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Oxide of iron	.73	Silica, etc	4.57
Calcium carbonate	70.53		
Magnesium carbonate	23.49		
	94.75		

Chemical Series, No. 83. A siliceous rock, to a great extent soluble in hydrochloric acid.

The rock was analyzed as a silicate, and its composition found to be as follows:—

Silica	19.81	per cent.
Alumina	52.43	"
Oxide of Iron	1.32	"
Calcium Carbonate	1.64	"
Soda	0.44	"
Water	23.23	"
	98.87	

In appearance this rock bears a considerable resemblance to compact gray limestone. Its hardness is a little less than that of limestone.

VII.

THE GEOLOGY OF THE DEEP WELL DRILLED BY C. C. WHELPLEY AT MINNEAPOLIS, AT THE "C" WASHBURN MILL.

BY N. H. WINCHELL.

(READ BEFORE THE MINNESOTA ACADEMY OF SCIENCES, JANUARY, 1882.)

I have just seen for the first time the record and drillings of this well (Dec. 1881), though the well was drilled some years ago, and the record and drillings were preserved at my request. The set sent me by Mr. Whelpley was lost in some way by being miscarried. The set on which these notes are based was encountered in the late moving of the effects of the Academy to new rooms, and I take the first opportunity to bring before the Academy what I deem important information concerning the strata that underlie the city, derived from an examination of this tube.*

In order to appreciate the bearing of the new facts on the geology of the region, it will be necessary to review briefly the former knowledge we had of the strata underlying the city. In the report of the geological survey for 1876, will be found a description of the geology of Hennepin county, by which it will be seen that the strata of the Lower Magnesian formation, represented by the Shakopee limestone extends under the St. Peter sandstone, occupying, conjecturally the surface of the western and central parts of the county. In the same report is a section of the deep well drilled in East Minneapolis, as furnished by the city engineer, Col. J. B. Clough, the designations of the strata being his, or of the party who drilled the well. The drillings of that well were not preserved, and it was found impossible to verify the designations by a comparison with them. It will be seen by that section that a "red limestone" was reported as penetrated, beginning at 234 feet and extending a depth of 102 feet farther. Under this is reported a "gray limestone." Below these, followed alternating, gray and white sandstones and shales with some sandy limestones, to the depth of 1074 feet. At that point the drill entered a red shale and sandstone which seems to have varied very little, if any, up to the time the work ceased at a depth of 1421 feet. This red shale and sandstone is the same formation in which the deep well stopped at Belle Plaine, and at other places in the State, the equivalent of the red shales of the Lake Superior region, the probable true Potsdam of the northwest. The well reported by Mr. Whelpley only goes to the depth of 205 feet, but as the drillings are presented with the recorded designations, it throws light on the geology of this part of the State which has a bearing on the proper interpretation of the deeper well of 1874. It is as follows, as given correctly by Mr. Whelpley:

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*The drillings from the well were exhibited in a glass tube about three feet long, in the order of their places in the strata.

1.	Peaty black soil	2	feet
2.	Drift sand and stones	8	"
3.	Limerock, (gray and blue)	24	"
4.	Blue clay, (shale)	2	"
5.	White sandrock	44	"
6.	Yellow sandrock	7	"
7.	White sandrock	41	"
8.	Yellow sandrock	3	"
9.	Fine, white sandrock	22	"
10.	Yellow sandrock	5	"
11.	White sandrock	2	"
12.	Pipestone clay, reddish brown	2	"
13.	Coarse, white sandrock, (water to top of ground)	21	"
14.	Coarse, gray sandrock	17	"
15.	Hard, gray sandrock	4	"
16.	Red rock, (grit) penetrated only	1	"
	Total depth	205	"

On comparing these records it will be seen that the former well penetrated the two feet of pipestone clay at about the depth of 197 feet (of its own record,) without any notice being taken of it. This supposition is more probably correct than that this clay was not encountered, judging from a general looseness of designation that seems to pervade the earlier part of that record, and from the nature of the stratum and the proximity of the wells to each other, (about one-third mile apart). Furthermore, the record of white sandrock continues alike in each well down to the depth of 204 feet in one, and 234 in the other, which, calculating from the top of the Trenton limerock, makes the "red rock" in one well (Whelpley's) appear at 195 feet, and in the other at 191 feet. This shows that there could have been no such disturbance in the bottom of the ocean as to have changed the detritus and caused the omission of the pipestone clay in the East Minneapolis well; which is also indicated by the fact, that the pipestone clay was extensive enough to confine under hydrostatic pressure, a volume of water which rose at once to the surface of the ground on being pierced by the drill.

All the sands underlying the blue clay below the Trenton limestone are essentially the same in character, being composed of rounded grains of pure quartz. These grains differ in size, the largest being about as large as a mustard seed, and the smallest too minute to distinguish with the unaided eye. They differ in color somewhat, passing from a pure limpid glass to snowy white, and to a buff color, and to a smoky gray. These colors are not due to the cement in which they were enclosed, but to an actual difference in the quartz itself. This difference of color implies some change in the source of the material, and suggests the enquiry whether that change were not in the waters of the ocean rather than on the land. On the supposition that this pure quartz were the result of chemical precipitation, these different colors in the same formations are easily accounted for by such changes as may have occurred in the ocean by shifting currents, allowing the mingling of certain other substances in solution, with the precipitated silica so as to stain it as it is. On the supposition that this sand is derived from the preexisting land as a sediment of detritus, it is very difficult to understand how such a source of pure silica, almost absolutely free from other sand and impurities, could be obtained and disseminated as widely as this sand is known to extend, and to change its inherent color from time to time.

The pipestone clay No. 12, is undistinguishable from similar clay and shale seen in the Potsdam formation at Fond du Lac. It is somewhat schistose in one of the fragments, and also has spots of green similar to the green spots seen in the same clay at Fond du Lac. In its schistose character it resembles some of the schistose, soapy, clays seen in the formation at Baraboo, Wisconsin, and at Sioux Falls, Dakota. It generally is a shale and has an angular fracture. In the midst of one of the fragments is seen a little grit cemented by the same substance that cements the red rock of No. 16.

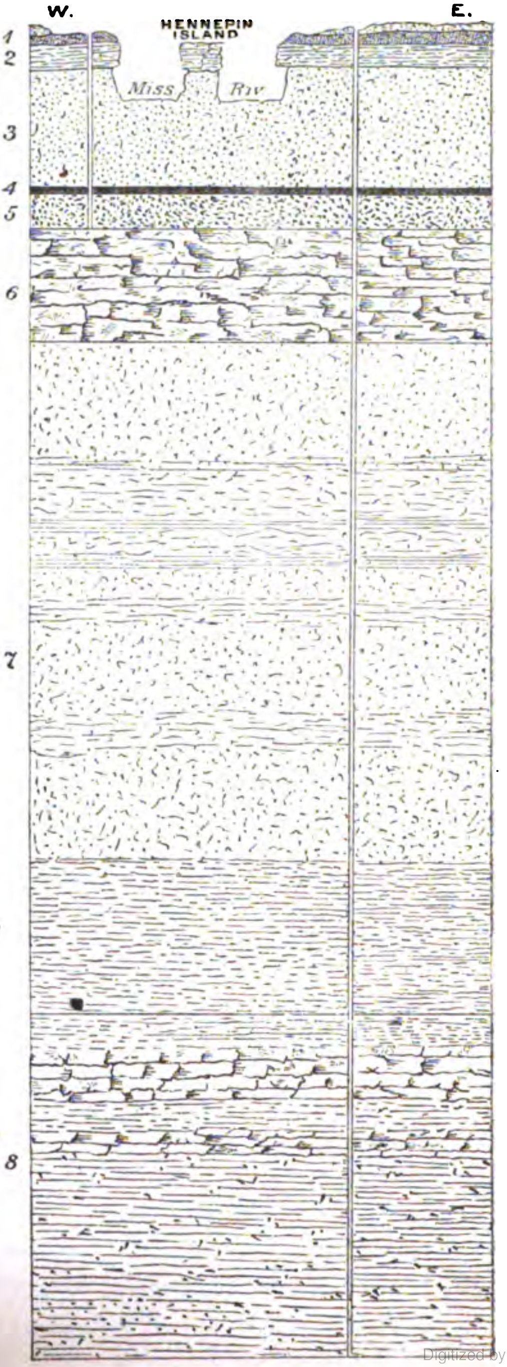
No. 16, which is the red limestone, so-called, of the East Minneapolis well, has not any of the qualities of a limestone. It is a coarse, red grit-stone, or arenaceous felsite, the grains being pure white silica, and the cement itself an amorphous red feldspathic substance seen to result in many cases from incipient metamorphism of the shales of the formation, disturbed by igneous eruptions, at Lake Superior. In other words it is a layer of the red quartzyte formation seen at New Ulm and at Baraboo, Wisconsin. The East Minneapolis well found this layer to be 102 feet thick, and to be underlain by other sands and shales, some of them being blue and gray to the thickness of 722 feet. Thus we find an interbedded red quartzyte in the Potsdam formation similar to those seen in the same formation in the Black Hills, and in several other places in the Rocky Mountain region.

I wish to call attention particularly to the occurrence of the red pipestone clay No. 12. This shows that the continuance of the disturbing causes, centering in and radiating from the region of Lake Superior, were still able to send a muddy agitation through the ocean sufficient to deposit a copious red sediment to the exclusion, almost entirely of the white quartz. This is within 127 feet of the bottom of the Trenton formation, and as nothing but white sandrock separates it from the Trenton formation, it demonstrates the absence of the entire Lower Magnesian formation. Thus we find the Trenton brought into contact with continuous white sandstone beds, which are shown, at least below 127 feet, to belong to the Potsdam formation. How much of this 127 feet may be of the St. Peter it is impossible to state, because there is no change in the character of the sandrock, but it is just as reasonable to suppose that the Potsdam continues upward to the Trenton at Minneapolis, in the same manner as it is reported to in Eastern Michigan, as to suppose the St. Peter sandrock, which is well known to exist between the Shakopee and Trenton further south, is brought on to the Potsdam, because in both cases it necessitates what might be styled an invisible unconformability between the Potsdam and the next overlying formation.

The question naturally arises—in what part of the Potsdam formation do these white sandstone layers belong? The answer must be, near the top, and probably quite at the top. This is evident from three considerations: First, there is an immense thickness of red sandstones and shales underlying them, as demonstrated by the East Minneapolis and by other wells in the State, which must belong to the formation, and which are the equivalent of the Lake Superior red shales and sandstones. Second, but a small thickness of sandstone supervenes before the Trenton formation is found overlying. These upper light sandstones must be older however than the layers which at Taylor's Falls lie unconformably on the trap rock, since there the formation had progressed far enough to admit of animal life, and dolomitic beds; and it is likely that the period of upheaval exhibited about Lake Superior had entirely ceased before the deposition of the Taylor's Falls sands and dolomites, setting off those and all succeeding layers into an era of comparative quiet.

In order to make the relations of these wells to each other, and to the geology of the region more evident, they are placed beside each other in perpendicular section, in figure No. 3.

FIG. 3.



Explanation of Figure 3.

1.	Drift	10	feet.
2.	Trenton limestone	24	"
3.	Light, crumbling sandstone (St. Peter?)	125	"
4.	Brown-red pipestone clay	2	"
5.	Potsdam sand	42	"
6.	Red quartzyte, Potsdam	102	"
7.	Light-colored Potsdam sand and shales	722	"
8.	Red Potsdam sandstone and shales, at least	347	"

VIII.

PAPERS ON THE CRUSTACEA OF THE FRESH WATERS OF MINNESOTA.

BY C. L. HERRICK.

I. *Cyclopidæ of Minnesota with notes on other Copepoda.*

II. *Notes on some Minnesota Cladocera.*

III. *On Notodromas and Cambarus.*

[NOTE.—The author feels it but justice to himself to state that part of the material here presented has been in its present form for some time. The work was begun in 1879.]

I. CYCLOPIDÆ OF MINNESOTA, *with notes on other Copepods.*

CALANIDÆ.

It seems that recent authors have sufficient ground for uniting the families *Calanidæ* and *Pontellidæ* under the single name; the value of these terms as subfamily names even may be questioned.

The family is represented in our limits by two genera and by three, or doubtfully more species.

The fifth pair of feet furnishes, by its modifications, the best criteria for distinguishing genera and species.

Genus DIAPTOMUS, Westwood.

Body elongated, compressed; head destinct from the thorax, anterior antennæ 25-jointed, those of the male geniculate on the right side; posterior antennæ and mouth parts as in *Calanus;* inner branches of all the swimming feet three-jointed except the first, which is two-jointed; fifth foot consisting of two unequal branches, prehensile; abdomen of male with five-joints, of female three-jointed.

DIAPTOMUS CASTOR.

(Plate I, figs. 1-7, Plate II, figs. 1-2, 16.)

Bibliography.

Monoculus castor, *Jurine.*
Cyclops castor, *Desmarest, Baird,* Mag. Zool. and Bot.
Cyclops cæruleus, *Muller, Latreille, Bosc.*
Monoculus cæruleus, *Fabricius, Manuel, Gmelin.*
Cyclops lacinulatus, *Muller, Ramdohr, Latreille, Bosc, Baird,* Trans. Beow. club.
Monoculus lacinulatus, *Manuel, Gmelin.*
Cyclops rubens, *Muller, Latreille, Bosc, Baird.*
Diaptomus castor, *Westwood, Baird, Baker.*
Cyclopsina castor, *M. Edwards, Baird, Claus.*
Glaucea rubens, *Koch,* Deutschlands Crust.
Glaucea cærulea, *Koch,* " "
Diaptomus castor, *Baird,* Brit. Entom.
Claus, Die Freilebenden Copepoden.
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castor, *Brady,* Brit. Copepoda.

The above bibliography is complete only up to a comparatively recent date; many notices may be found in recent literature.

The species which, after careful study, has been considered identical with the European *D. castor* is that described previously as *D. longicornis* with the remark that it might prove too near *D. castor*. *D. sanguineus*, Forbes, seems to be the same thing nearly. If the amount of variability admitted by Brady to prevail is allowable I see no reason for separating this species. It is very variable as to size and coloration, and even in the configuration of some of the parts, as antennæ, etc., a certain amount of latitude is to be given; (See plates of Claus, Zur Anatomie und Entwicklungs-geschichte der Copepoden Arch. f. Naturg. XXIV Jahrg., B I.) $\frac{14}{100}$-$\frac{18}{100}$; cm. in length. The following points are variable:—length of caudal stylets, structure and thickness of male geniculating antenna, size of claw of fifth male foot and spinous armature of feet. How far such variations may extend and how much they are dependent on peculiarities of habitat, etc., farther study must demonstrate. Some interesting facts meanwhile are suggestive. A second and gigantic form which may be known as

Diaptomus giganteus.

(Plate II, figs. 3-11-15.)

with the reservation that it is doubtfully of more than varietal value, was found under such circumstances as to suggest that it might be only a curiously magnified condition of *D. castor*. It is known to occur only in a small marshy pool of about two square rods extent and which annually dries up nearly completely. A few yards away is a second pool of a somewhat greater size and which less frequently dries up in summer. These two pools within the memory of the writer were united, but in the gradual dessication which has been observed in all Minnesota, they have been isolated. The former pool in June was found to contain *mature* males and females of the *D. giganteus only*, few other copepods being present, while the other pool contained *all stages* of the common *D. castor*. There are no neighboring waters, the nearest being half a mile, and that (L. of Isles) has only *D. castor*.

The smaller pool soon completely dried up so that this form was, for the time, exterminated. The conclusion seems almost resistless that the stagnation incident to evaporation produced circumstances favorable to the development of this enlarged form. At any rate it is an interesting fact in local distribution.

This variety is $\frac{3}{10}$ cm. long or more, and is much the largest fresh water copepod known to me; it is a deep red in color and very compactly framed. Although so much larger than *D. castor*, it is almost impossible to find any structural differences. The male fifth foot differs somewhat, but mainly in the enlargement of one part at the expense of the others. The thorns on the feet are strongly pectinate and the larger ones bear short spines instead of bristles.

Diaptomus armatus, sp. n.

(*See accompanying cut.*)

A second form is imperfectly known, but presents some clearly marked distinctions which may have specific value.

Length about as *D. castor*; body slender; antennæ reaching base of abdomen only; female differing otherwise but little from *D. castor* (?); male considerably smaller; caudal stylets narrow; antennæ peculiar, shorter than the body; thickened portion of the geniculate antenna short; two last joints very short; one preceding the second long, bearing a hook at end; fifth foot with a very long claw to longer ramus (nearly as long as the ramus itself) with a tooth on the inner margin near the base, not perfectly arcuate, reaching, when extended, to end of caudal setæ.

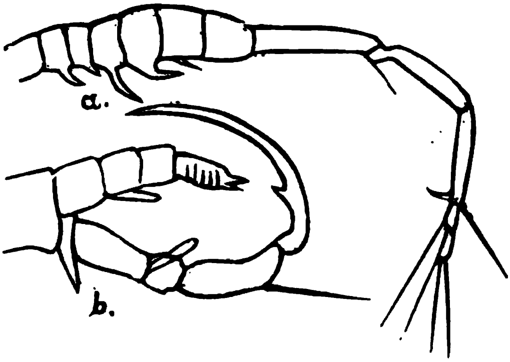

Fig. 1.

Diaptomus armatus.

a. part of male antenna. b. fifth foot of male.

Genus POTOMOICHETOR,* Gen. nov.

Cephalothorax six-jointed as in *Diaptomus*, but with the distal segment more evident; abdomen, in the male, five-jointed, *in the female*

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*River inhabitor.

four-jointed; antennæ *twenty-four* jointed, the right geniculated as in *Centropages* (=*Ichthyophorbia*); first pair of feet with the rami *both three-jointed*, like the following; feet of the fifth pair, in the female, like the preceding, but with a spine of the joint preceding the terminal one enlarged and divaricated somewhat as in *Centropages*; in the male, the right with a two-jointed outer ramus, the terminal joint of which is spined and bears near its base a blunt expression of its inner margin; outer ramus of left foot three-jointed, armed with unequal spines; inner branches smaller, similar, three-jointed; the terminal joint bearing curved spines; ovary and testes as in *Diaptomus*, with which the mouth parts agree in the main; eyes medium, confluent; no lower or secondary eye-spots.

POTOMOICHETOR FUCOSUS, sp. nov.

(Plate II, Figs. 12-14. Plate III, Figs. 1-8, 13-14.)

Rather slender, and in size, as well as general appearance, resembling the smaller forms of *Diaptomus castor*; antennæ rather stout, reaching but little beyond the feet, appendaged as in D. *castor*, in the male strongly geniculated, but somewhat variously so; the six joints preceding the terminal four are thickened; those preceding the joint or hinge are arcuate on the distal margins; the secondary antennæ are about as in Diaptomus; mandibular palp two-branched; the outer three-jointed, the inner two-jointed; the terminal joint of the shorter branch bearing seven setæ, of the other four, the proximal joint of the former with three stout spines; the maxillæ nearly like *Diaptomus*; the processes have respectively the following numbers of setæ: the basal plate eight, the small process at base of posterior branchial appendage one, the appendage itself twelve, terminal portion three groups, first containing nine, the second three and the third four or five, the upper of the anterior processes two and the lower three; fifth feet nearly like the others in size; the right in the male having the outer branch but two-jointed by the coalescence of the two outer to form an arcuate and deformed appendage armed at the end with three stout equal spines; corresponding branch of left foot three-jointed; the terminal joint bearing three unequal spines, each of the preceding but one; inner branches similar, three-jointed; terminal joint being short and armed with three short lanceolate setæ and three longer ones, two of which are curved so as to be slightly prehensile; fifth foot of female with both rami three-jointed; inner ramus much smaller; antepenult segment of the outer ramus extending into a large lanceolate process; ova sac long-elipsoidal reaching to nearly the end of caudal setæ.

This species prefers running water or estuaries of streams. Crow river, Meeker county, and a brook between Minneapolis and St. Paul.

NOTE ON CANTHOCAMPUS.

Claus says (*Freilebenden Copepoden*, p 121) that he could not find the coiled "shell gland" in Canthocampus, though it is described by Leydig. I have found it in a European species, (*C. minutus?*) and think it constant. Canthocampus also has a singular area of nervous hairs upon the forehead, and in the same situation, pits which seem rudimentary eye-spots and sometimes appear to be pigmented. The pentagonal area mentioned is bounded by a raised line.

CYCLOPIDÆ

Contains five genera, viz.: *Thorellia*, *Cyclops*. *Oithona*, *Lophophorus* and *Cyclopina*; passing, by the genera *Misophria* and *Pseudocyclops*, into the *Calanidæ* or marine copepods. The affinities of these little studied genera need further study, as they are very interesting, the question being still open in how far the cyclopoid forms are altered by adaptation to saline habitat, if such an adaptation takes place at all.

The following is Brady's definition:

Cephalothorax ovate and usually much more robust than the abdomen; anterior antennæ seldom longer than the cephalothorax, those of the male alike on both sides and modified for the purpose of clasping: posterior antennæ branched (i. e. palpus wanting); palps of mandibles and maxillæ usually well-developed; foot-jaws mostly less developed than in *Calanidæ*; first four pairs of feet as in *Calanidæ*, fifth pair rudimentary, alike in both sexes, and usually one-jointed; ovisacs two.

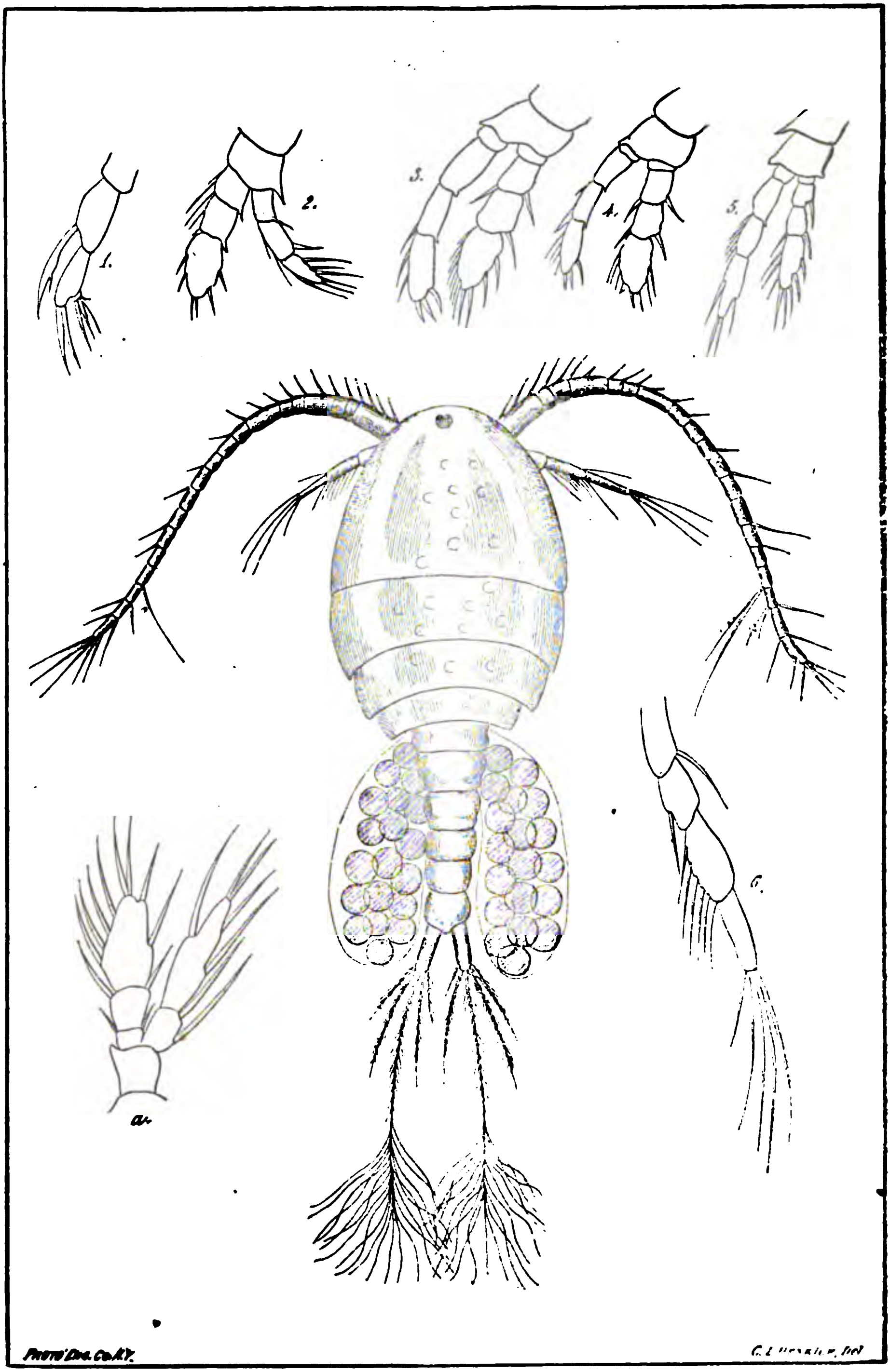

PHOTO ENG. CO. N.Y.

C. L. Herrick, Del.

Fig. 2.

A Cyclops with abnormally pectinated caudal setæ.

Genus CYCLOPS.

Brady well says of this genus: "As regards discrimination of species it is, perhaps, the most difficult and puzzling of all the Copepoda." He also states that "the only safe rule in this state of things is to accept no specimens as types which do not show amongst them ova-bearing females." It is necessary, however, to limit the matter more closely, as will be shown farther on, for not only do immature females become fruitful even while the antennæ are yet incompletely developed, but the species are subject to a sort of dimorphism which it is interesting to parallelize with that in the males of *Cambarus*. The species are all fresh-water, so far as it is at present known, though it may be that salt-water forms exist under other names.

The characters of the family with some limitations apply to the genus.

The following species are probably but few of those which occur even in Minnesota, but they are so clearly defined, for the most part, as to be unmistakable and their description it is hoped will form a foundation upon which to lay later study.—Observations extend over a term of about four years.

Species with seventeen-jointed Antennæ.

CYCLOPS TENUICORNIS, Claus.

Bibliography.

Plate VI, figs. 1-11, 20. Plate V, fig. 14.

Cyclops tenuicornis, *Claus*, Das Genus Cyclops.
Die Frei-lebenden Copepoden.
Sars, Oversigt af de Indenlandske.
Ferskvands Copepoder.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
Cyclops signatus, *Koch*, Deutschlands Crust.
G. O. Sars. *Uljanin*. *Brady*.
Cyclops coronatus, *Claus*. *Fric*.

We feel confident that the two forms distinguished by Claus as *C. coronatus* (=*signatus*) and *C. tenuicornis* should be united, as the only distinction which is at all reliable, is the knife-like serrated ridge on the last joint of the antennæ. The last joints are frequently longer in *tenuicornis* form, as are the stylets in *coronatus*, but this varies. In the same gathering (for in so far as we have observed they occur together where circumstances permit a full development,) the *coronatus*-form is larger and carries more numerous eggs. No young with the serrated antennæ have been seen, though searched for diligently. On the other hand young forms of *tenuicornis* abound, and we have seen females with incompletely grown antennæ with egg-sacs. In view of these and similar facts, we feel justified in considering *coronatus* probably a post-imago of *tenuicornis*.

Cephalothorax broad; abdomen rather slender; antennæ reaching about to base of throax, attenuated at the end; terminal joint with a knife-like ridge; formula — ◡ ◡ — ≍ ◡ — ◡ ◡ ◡ ◡ ◡ ◡ ◡ — — —; fifth foot composed of a long basal joint bearing a long spine and a terminal three-spined division; caudal stylets over twice as long as last abdominal segment; setæ all nearly terminal, inner one much longer than usual, length $\frac{25}{100}$ cm.

Common in America, England and continental Europe.

CYCLOPS ATER, n. sp.

(Plate III, figs. 9-12.)

Length about $\frac{21}{100}$ cm; antennæ as long as cephalothorax, $\frac{12}{100}$ cm., slender and gradually tapering; formula* — ≍ ◡ — — ◡ — ◡ ◡ ◡ ◡ ≍ ≍ ◡ — — —; terminal joints rather short; the last joint furnished with a knife-like ridge as in *tenuicornis*; second antennæ much as in *tenuicornis*; maxillipeds rather large; fifth foot one-jointed, armed with three subequal spines; abdomen rather short, last segment very short; stylets somewhat elongated; setæ rather short, lateral seta near the end; eggs pale; color deep blue or gray.

This beautiful and very distinct species is found in "Mud Lake" in Hennepin county, with *Cyclops signatus*. The large very dark cephalothorax and shortened abdomen make it conspicuous. The one-jointed fifth foot, shape of the operculum vulvæ in connection with the shortened joints of antennæ and characters of the caudal stylets, make the species sufficiently distinct from any other.

CYCLOPS INGENS, sp. nov.

(Plate IV, figs. 1-8.)

A large species perhaps too near *C. gigas*, or *C. brevicornis* Claus, but differing from the former as to the length of antennæ and stylets and in not having the distal margins spined (except in some cases?) and from the latter in size and arrangement of caudal setæ.

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*Note. The accent marks are used to signify that joints represented by them (counting from base), are either long —, short ◡, medium ≍.

Thorax large; abdomen rather slender; stylets rather slender with the lateral seta well towards the end; second and third setæ alone long, weakly pectinate; last joint but one of abdomen sometimes toothed along the distal, under margin; maxillipeds as in *C. gigas;* jaws with large teeth; antennæ very short not reaching to the base of the first cephalothoracic segment; formula — ⏓ ⏑ — ⏓ ⏑ — ⏑ ⏑ ⏑ ⏑ ⏑ ⏑ ⏑ ⏑ ⏓ ⏓; fifth foot two-jointed, the proximal joint very broad with a strong spine, second joint cylindrical with a long seta and a very short spine near the end; operculum vulvæ somewhat heart-shaped; egg sacs oval-elongated, reaching beyond the end of abdomen; length $\frac{40}{100}$ cm. including stylets and setæ.

This is one of the largest and finest as well as rarest of our forms and loves, as it appears, lakes having outlets.

Small forms with seventeen-jointed Antennæ.

CYCLOPS NAVUS, sp. nov

(Plate V, figs. 6-13-15-17.)

Closely related to *Cyclops pulchellus*, Koch, and to *Cyclops strenuus*, Fischer.

Rather slender; abdomen long; stylets about three times as long as last segment of abdomen; lateral seta rather stout; outer and inner terminal setæ minute; middle ones of moderate length; antennæ short, reaching barely to or but little beyond the end of first segment; formula — ⏓ ⏑ — ⏓ ⏑ — ⏑ ⏑ ⏑ ⏑ ⏑ ⏑ ⏑ ⏓ ⏓ ⏓; fifth feet two-jointed, terminal joint large, with two considerable spines; operculum vulvæ of peculiar shape; length $\frac{11}{100}$ cm. excluding setæ.

Quite abundant and perhaps passing into the following.

CYCLOPS PARCUS, sp. nov.

(Plate VI, figs 12-15)

Almost exactly like the last but not yet found in the same waters. Distinguished by the broad and short basal joint of the fifth foot which extends into a process carrying a spine, the slender second joint with a single long spine and a short thorn, and by the oval shape of the operculum vulvæ.

The caudal setæ are naked for about a third of their length. These distinctions seem constant.

Section with twelve-jointed Antennæ.

CYCLOPS SERRULATUS, Fischer.

(Plate V, figs. 1-5, Plate VII, fig. 10.)

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Frei-lebenden Copepoden.
Fric, Die Krustenthiere Böhmens.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
? Cyclops minutus, *Claus*, loc cit. (young.)
? Cyclops macrurus, *Sars*, loc. cit.
? Cyclops spinulosus, *Claus*, loc. cit.

Typical Form.

Cephalothorax oval, compact; abdomen slender and short, suddenly enlarged previous to its union with the thorax; antennæ slender, reaching nearly, but not quite to the last thoracic segment; the last three joints are attenuated and furnish the most evident character of the species; formula — ⏓ ⏑ — ⏑ ⏑ ⏓ — ⏑ — — —; during life the antennæ tend to assume the form of a rude Z, the proximal four joints forming the base; antennules small, reaching about to the sixth joint of antennæ; jaws small with large teeth; the single segment of the fifth foot with three equal spines; egg sacs oval, as long as the abdomen; eggs few, dark; caudal stylets very long and slender, spined along the outer margin; lateral setæ small and approximated to the upper one; outer terminal seta short, spine-like, in life set nearly at right angles to the others, spined or beaded on one margin and bristled on the other; the next seta is as long as the abdomen, being somewhat exceeded by the following one; inner seta insignificant; upper seta very small; length less than $\frac{1}{10}$ cm.

A larger form occurs with an elongated body and abdomen and with extremely attenuated antennæ and caudal stylets, but it is not a va riety induced by alpine habitat as suggested by Brady, occurring as a "post imago" form with the ordinary type. Claus' description of *Cyclops spinulosus* suggests that this form may be the basis of his species though the form of the male antenna is different from any yet seen. *Cyclops minutus*, Claus, is most certainly the young of some Cyclops, as is indicated both by the description and figures in *Die Freilebenden Copepoden*. Though placed among the twelve-jointed forms the antennæ are eleven-jointed. The fact tbat the females may have had egg sacs is no proof of their maturity as I have seen undoubted larval forms of *serullatus* with the sacs. Moreover *two-jointed branches of swimming* fect is a larval character. This is a cosmopolitan and very abundant species, occurring in almost all pools and lakes about Minneapolis. The form and structure of the stylets, antennæ and feet make it an easily recognized species.

CYCLOPS FLUVIATILIS, sp. nov.

(Plate VII, figs. 1-9.)

A very small and distinct species of the section with 12-jointed antennæ was found in an estuary of the Mississippi river, (also later in L. Minnetonka) with the following characters:—

Body elongated; thorax very long; abdomen slender; stylets about as long or longer than last abdominal segment; setæ all very short, not pectinate; lateral and dorsal setæ very small; outer one spine-like, short and stout, two middle short, inner one very small and inconspicuous; antennæ reaching nearly to the base of abdomen; formula, $- \overset{\smile}{-} \smile - \overset{-}{-} - - - - - - -$; the three joints following the six basal are much elongated while the terminal ones are but moderately so, a character which is peculiar to this species; terminal segment slightly but evidently hinged, and together with pair preceding somewhat curved; feet with the terminal spines strongly toothed; fifth foot very small, one-jointed, bearing three small setæ; operculum vulvæ heart-shaped; egg sacs subquadrangular; eggs large; abdomen in the young much elongated; color deep indigo, length $\frac{3}{100}$ cm.

CYCLOPS ADOLESCENS, sp. nov.

(Plate VI, figs. 16-20.)

The form figured under the above name seems closely allied to *C. affinis*, Sars, from which it differs chiefly in the arrangement of the joints of antennæ.

The body passes without marked transition into the abdomen which is abnormally shortened; caudal stylets very short as is the last segment of the abdomen; setæ exactly as in C. *parcus* with which it was found; antennæ eleven-jointed; formula — ⏑ — ⏑ ⏑ ⏓ ⏓ ⏑ ⏓ —; a semi-circular series of spines upon the basal joint; fifth foot obsolescent, the three spines appearing to spring directly from the last thoracic segment which also bears a series of teeth; egg-sac reaching to base of abdomen, with rather numerous eggs; feet heavily spined on one margin; length $\frac{11}{100}$ cm., male $\frac{9}{100}$ cm.

This species, together with all others of this sort with eleven-jointed antennæ, is perhaps but an immature and abnormally modified form of some of the common species If this be true the rarity of these nominal species is explained. *C. minutus*, Claus, is certainly but a larval form, as is shown by the two-jointed branches of swimming feet.

Section with 8-jointed Antennæ.

CYCLOPS CRASSICORNIS, Müller.

(Plate IV, figs. 9-14.)

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Cyclops crassicornis, ***Muller***, Entomostraca.
Sars, Oversigt Ferskvands Copepoder.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
pauper, ***Fric***, Die Krustenthiere Böhemens.
? magniceps, ***Lilljeborg***, De crustaceis ex ordinibus tribus, etc.

A small species characterized by its small size and the eight-jointed antennæ; body depressed and passing gradually into the rather uniform abdomen; first cephalothoracic joint large; abdomen rather slender; stylets of moderate length, spined along the outer margin somewhat as in *C. serrulatus*; outer seta lance-shaped, short; the next one as long as stylets and last two segments; the following one nearly twice as long; inner one very small; last joint of abdomen spined; the preceding one fringed on distal margin with weak setæ; antennæ short, not reaching the base of first segment; formula — — ⏓ — ⏑ ⏑ ⏑ ⏓; the basal joint with a semi-circular set of fine bristles, and with the following is furnished with pectinate setæ; second antennæ short; terminal joint short, with two curved, strong spines and other weaker ones; fifth feet small one-jointed with three unequal spines, bordered above by a spined plate of the last thoracic segment; length about $\frac{11}{100}$ cm. excluding setæ.

This species appears not to be very abundant, or at least from its small size it is not often encountered. A few particulars distinguish these western forms from the description given by Brady, among them being the spinous armature of the stylets, the bristles on the penultinate segment of the abdomen, pectinate bristles of the fifth feet, and the greater length of the abdomen, yet I see no reason for separating them. I have not seen the male and can not be sure that there is no further development, but the fact that the feet in this form are three-jointed, and its peculiar characters, clearly distinguish the species from any other known to me.

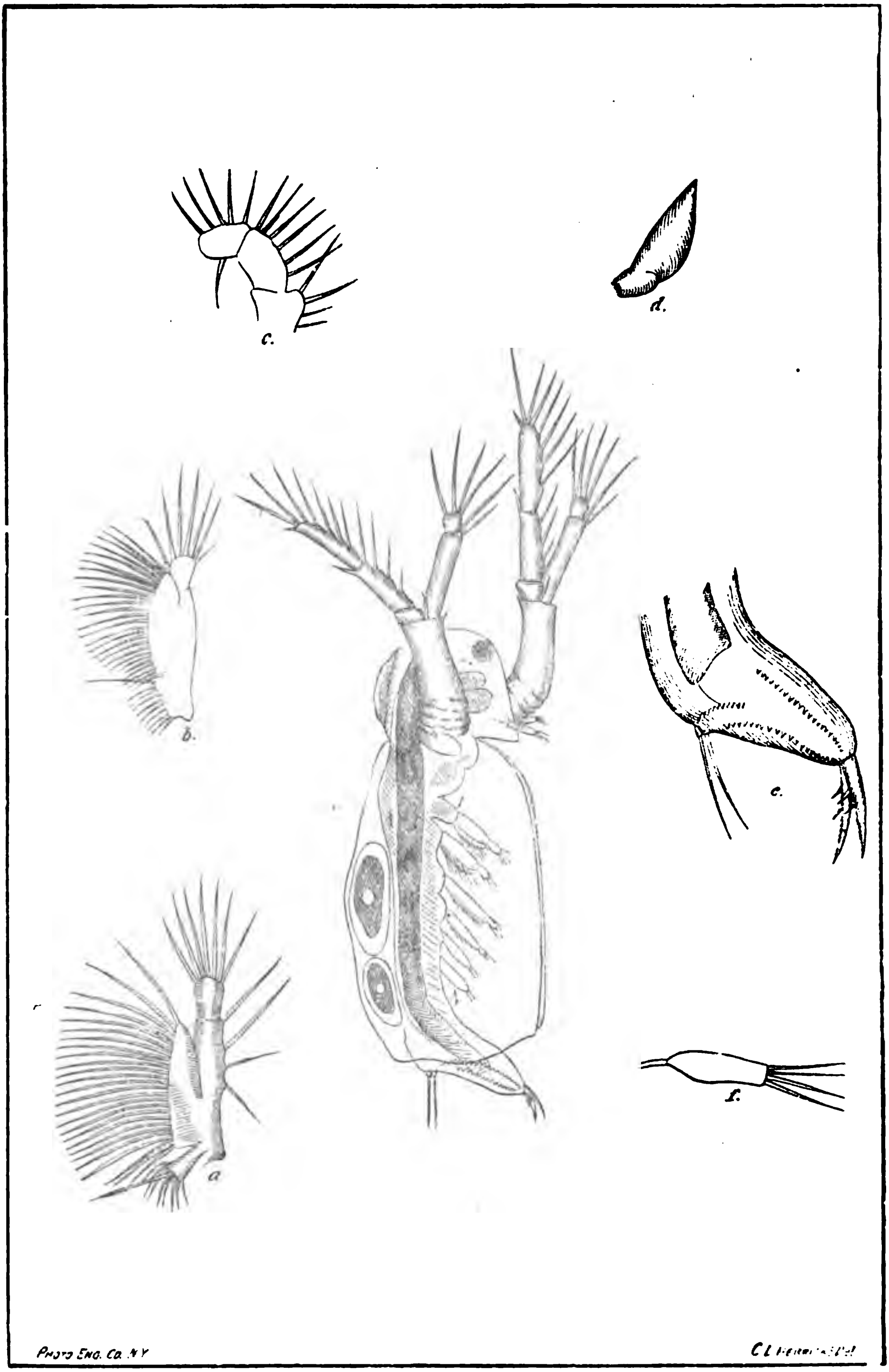

Fig. 3, ***Sida** crystallina.*

II. NOTES ON SOME MINNESOTA CLADOCERA.

Tribe I CTENOPODA.

SIDIDÆ.

Antennæ of second pair with unequal rami, superior larger; last joints compressed and setose; intestine simple.

Of this family two species are certainly identified in America, both of which are abundant in certain favorable locations at the proper seasons. No species of the *Holopedidæ* are known to occur here.

Genus SIDA Straus.

Superior ramus of second antennæ three-jointed; posterior margin of post-abdomen with numerous spines (20-30.)

SIDA CRYSTALLINA, Müller.

(Fig. 3.)

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I note this cosmopolitan species, of which a nearly complete bibliography is given above, simply to mention that I have recently found for the first time specimens of *Sida* reaching the size mentioned by P. E. Müller ($\frac{30}{100}$ cm.)

In smaller pools, when present our *Sida* is much (often $\frac{1}{2}$) smaller, and only in L. Minnetonka does the species attain its ultimate development.

Genus DAPHNELLA.

Superior ramus of second antennæ apparently 2-jointed, narrow; post-abdomen destitute of spines.

DAPHNELLA BRACHYURA Lievin.

(Plate VII, 11-16)

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(Compare also *D. expinosa*, Birge, Notes on Cladocera p. 3.)

The species of ***Daphnella*** found about Minneapolis, occasionally abundant, seems not to differ in any important character from European types of *D. brachyura* although I formerly regarded it as distinct (*D. winchelli.*)

Head less than one-half the body (about $\frac{27}{1000}$ cm. while body is $\frac{6}{1000}$ cm. long); eye about $\frac{1}{4}$ head; antennæ when reflexed extend a little beyond $\frac{3}{5}$ the length of body. Male $\frac{7}{100}$ cm. long; antennæ reflexed reaching base of shell; anterior antennæ extremely long; copulating organs reaching nearly to end of claws. Having carefully compared our specimens with the description and figures given by Birge for his *D. expinosa*, the evidence seems to indicate not only that they are identical but both are really *D. barchyura*. The distinctive characters of *D. expinosa* are a greater indentation between head and body, absence of caudal teeth, greater length of male appendages, and the opening of the vasa deferentia in the "instep" of these appendages.

The absence of t [illegible] on the post-abdomen is of even generic importance according [illegible] s, who gives it in his synopsis of genera as typical for *Daphnella*. In our specimens the claws are at least pectinate if not serrate, while the appendages of the male reach generally nearly to the middle of the claws. The relative length of these appendages and the antennæ of male is variable.

Tribe II, ANOMOPODA.

DAPHNIDÆ.

Rami of antennæ 3 and 4-jointed; feet of five pairs; intestine with anterior cœca not convolute.

Genus MOINA, Baird.

A transition between *Sididæ* and *Daphnidæ* is made through this genus.

Head separated from the body by a depression; macula nigra absent; antennæ of female large, movable, of male very long, curved; first foot of male with strong hook; valves short, truncate behind.

MOINA BRACHIATA.

We believe with P. E. Müller that this and *M. rectirostris* are identical. The most complete discussion of the merits of the three species (the above and M. paradoxa) is found in Weismann's paper, *Ueber einige neue oder unvollkommen gekannte Daphniden*, Grüber and Weismann, 1877, which see for bibliography and elaborate, not to say labored, distinctions. This species is not common, but when found (in muddy pools in late summer) frequently appears in great numbers. For embryology see *Grobben*, Entwicklungsgeschichte der Moina rectirostris.

Genus DAPHNIA.

This genus as limited by Müller is well distinguished from the remaining genera of the family—*Simocephalus, Scapholeberis, Ceriodaphnia* and *Moina*.

As remarked by Birge, this is not the typical representative of the group but is a very divergent member of it, worthy, probably, of forming a distinct section or sub-family. The most remarkable feature is one which appears in a comparatively early embryonic period and, in some cases, nearly disappears in later life. This is the development of a long spine from the dorsal, posterior end of the shell. This is the real diagnostic test and has not yet been incorporated into the definition of the genus The occurrence of a crista is more variable apparently, but may be of some importance.

The following is suggested as a revision of the diagnosis:

Shell more or less oval or sub-quadrate and reticulate; head rounded anteriorly, but sometimes with a crest, prolonged below into a beak which is truncate posteriorly and bears the antennæ near the apex; upper dorsal corner of shell in young of both sexes and mature males prolonged into a long spine; the macula nigra is present but not always pigmented; the post-abdomen spined behind; opening of rectum at the end.

The female with two age-forms (heterogenetic and dimorphic); the second form frequently scarcely spined; antennæ small, not movable, furnished with sense-hairs; ephippium with two ova, separable from remainder of shell along the latero-median suture; the brood-cavity closed by more than two unequal processes of the abdomen.

Male with long movable (almost two-jointed) antennæ furnished with prehensile stylus; first foot bearing a curved claw; swimming antennæ very long; vas deferens opening at the end of post-abdomen. Embryo with second antennæ palpate; a curved appendage to shell which becomes the spine of adult.

DAPHNIA PULEX.

This species is mentioned here simply to remark concerning *D. pulex*, var *denticulata* of Birge, (Notes on Cladocera, p. 11, plate I, fig. 11,) that the European as well as all the American specimens of *D. pulex*, have a fine series of spines on the claws of the post-abdomen. A glance at Tafel XII, fig. 39, of the Zeitschrift für Wiss. Zoöl. Bd. XXXIII, with Weismann's plate of the end of the abdomen of this species, is sufficient evidence of this fact, though as the animal is a male and quite young, the spines are less evident; moreover the number of caudal teeth is known to be variable with age. Some other peculiarity must be found to give this varietal distinction validity.

DAPHNIA sp?

(Plate X, figs. 15-16).

From a cold marsh a gathering in June, 1882, contained several females like that represented by fig. 16. They were far from being abundant, however, and the pool contained no other Daphnia showing that it was unfavorable to the growth of these animals.

These females differ from *D. pulex* chiefly in their small size, ($\frac{14}{100}$ cm.) being the smallest Daphnia seen with an evidently mature appearance. The caudal spine is sickle-shaped; post-abdomen as in *pulex*; antennæ short; the animal beautifully clear and varigated by the brilliant contents of ovary, eggs and intestine. I hesitate to regard it as a destinct species.

Figure 15 represents a single specimen of Daphnia found with the above which was somewhat injured during its moult. This resembles *D. apicata*, Kurz, and *D. pellucida*, Müller, and is perhaps the male of the species represented by fig. 16. Our knowledge of the variations induced by environment is yet too meager to draw up definitions of species with certainty from a single gathering, but these forms are peculiarly interesting.

See also the accompanying figure, (fig. 4,). These forms merit closer study.

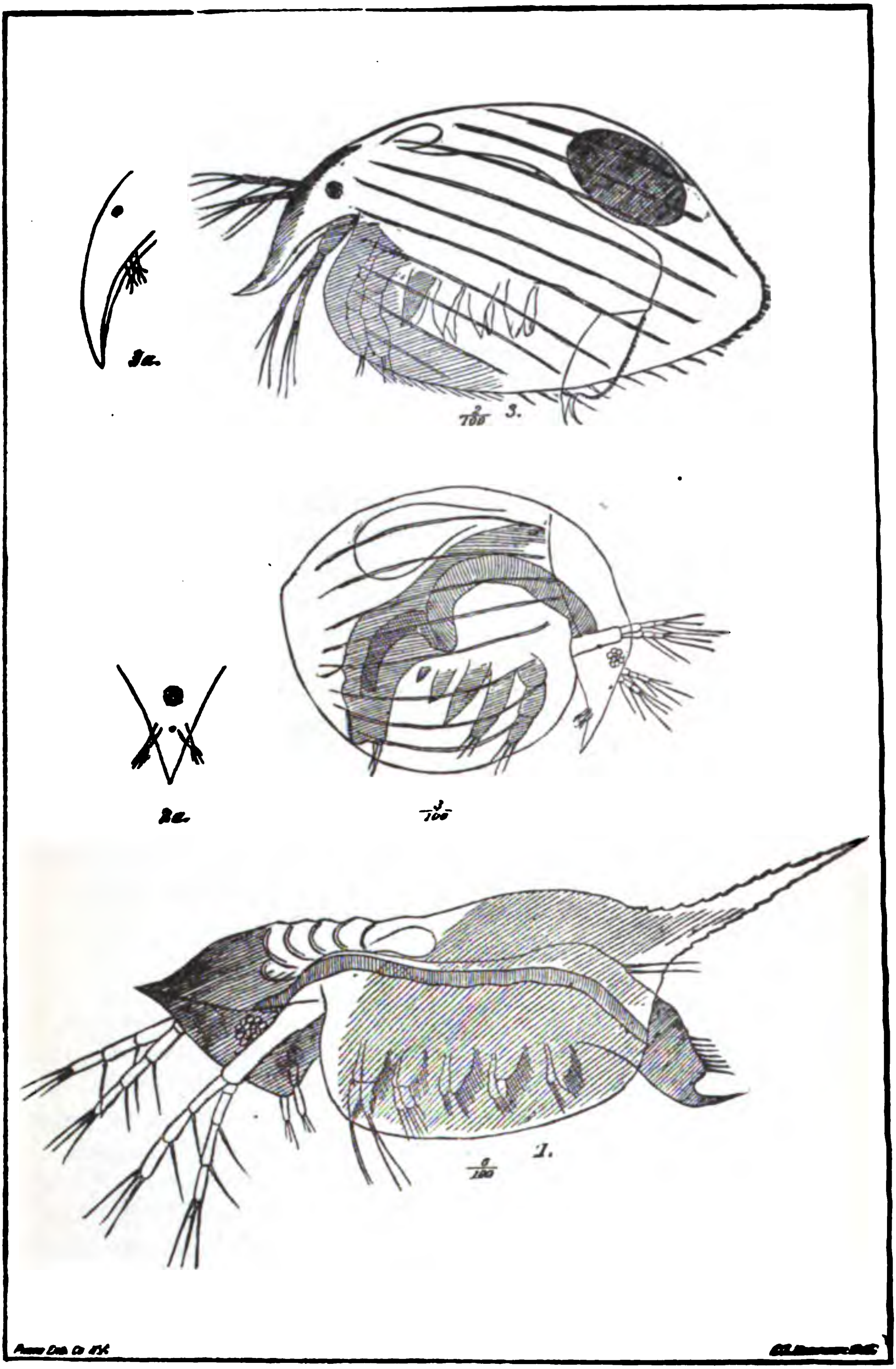


Fig. 4. Daphnia longispina (numbered 1) etc.

SCAPHOLEBERIS, Schödler.

In a former paper *S. mucronata* was reported from this locality with the remark that only the unhorned variety seems to occur here. A rather diligent search has failed to find var. *fronte cornuto*, though our waters have been carefully searched at intervals for several years and at different seasons. Birge quotes only this variety. However, the species is not common and the other form may yet be discovered. See Fig. 5.

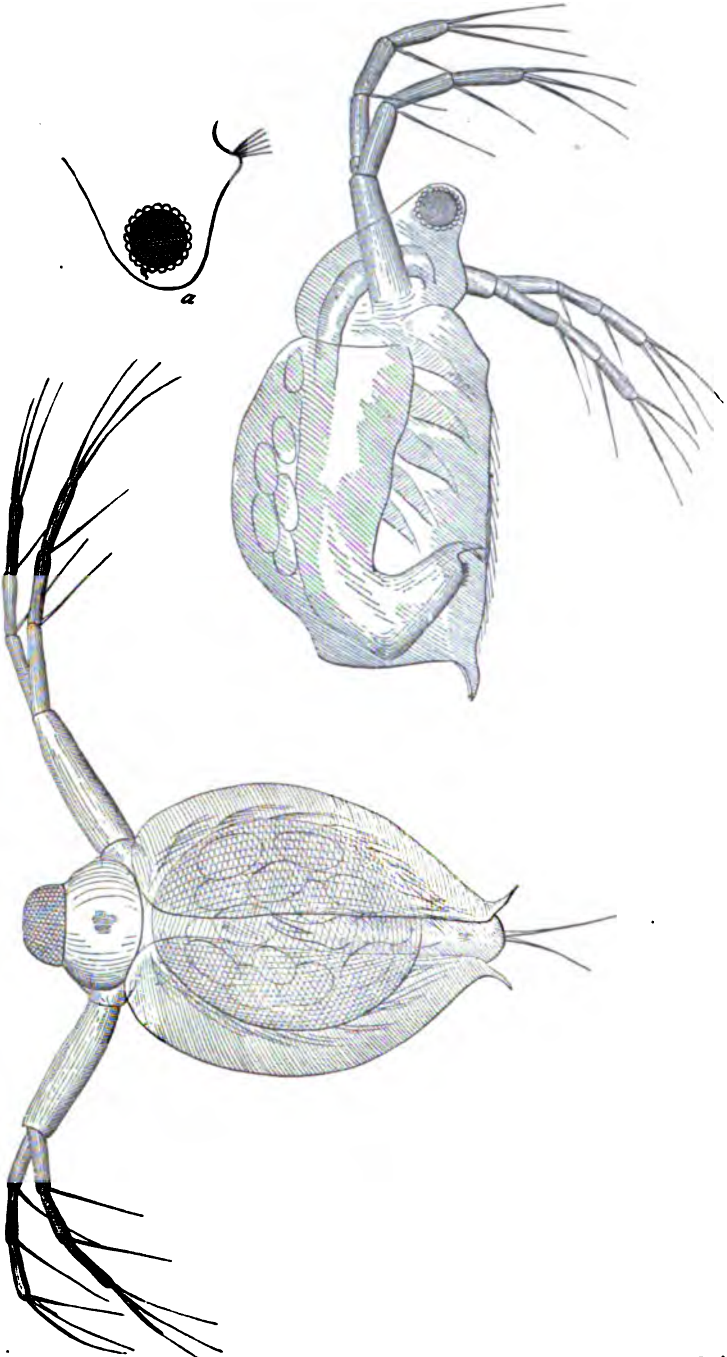


Photo Eng. Co. N.Y.

C. L. Herrick Del.

Fig. 5. Scapholeberis mucronata.

A second variety or species has been found which differs somewhat from typical *mucronata*, but does not appear to be *nasuta* of Birge. Is not the latter a variety simply?

SCAPHOLEBERIS ARMATA var.? nov.

Length $\frac{7}{100}$ - $\frac{8}{100}$ cm.; much as *S. mucronata* in form; but the spines are greatly elongated in old as well as young individuals; and in individuals having winter as well as summer eggs, though the winter form seems to have longer spines which are nearly equal in some cases to the hight. Antennæ are short and transparent. The head is separated from the body by a marked depression; but is curved forward so that the beak lies generally between the valves. The antennules are of medium size. Nowhere reticulate (?) nor tuberculate. The shell is marked by impressed lines, especially anteriorly and below. The lower margin is straight and beaded anteriorly, but toward the base of the *mucro* are several long bristles which stop abruptly and are followed by a few very weak hairs. The post-abdomen has three teeth at the base of the claws, which are smooth.

This variety is much like *S. nasuta* of Birge, perhaps, but differs perceptably in several points. Most conspicuous are the greatly elongated spines and the short antennæ. This variety is about as large as *mucronata* but less than *nasuta*.

BOSMINIDÆ.

Genus BOSMINA.

First antennæ many-jointed; intestine straight. Sole genus of the family, and one which Kurz characterizes as "one of the most difficult of the genera of Cladocera."

There are three species known in the United States, two of which are found from the Eastern States to the Mississippi and westward, and are identical with European forms. The third may not prove distinct.

BOSMINA LONGIROSTRIS.

(Plate X, fig. 2.)

Differs from the following in having the terminal claws not toothed, and from *B. striata* in the shorter antennæ and reticulate shell.

BOSMINA CORNUTA.

(Plate IX, figs. 3–5.)

$\frac{35}{000}$ cm. long; shell reticulate with hexagonal meshes; antennæ curved backward and outward at the tip; claws with several teeth near the base. In embryonic specimens the antennæ are straight.

BOSMINA STRIATA, sp. n.

(Plate IX, fig. 1).

$\frac{25}{1000}$ cm. long; shell marked with anastomosing longitudinal striæ; antennæ very long; frontal seta about midway between eye and the sense-hairs of the antennæ: posterior inferior angle of shell spined as in the previous species.

The species resembles *B. maritima* greatly. The members of this genus have been little studied owing to their small size and comparative rarity, and it is even possible that some of the species will prove invalid.

All three of the above species were found in one gathering from Lake Minnetonka. Only one other locality (for *B. longirostris*) is known to me in this State.

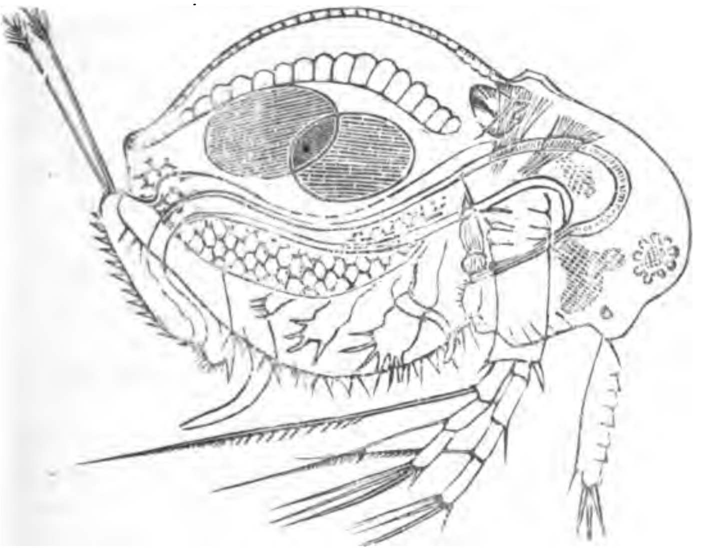
LYNCODAPHNIDÆ.

Genus MACROTHRIX.

Aside from *M. roseus* and *M. tenuicornis* (to which, perhaps, *M. agilis* of a previous report may be referred) a single species of macrothroid crustacean was collected at Lake Minnetonka, which is very remarkable. The specimen was apparently somewhat injured in moulting, and it is not possible to tell how much of its peculiar shape may be due to this fact, but some of its characters are sufficient evidence that it constitutes at least a new species.

It resembles in outline *Simocephalus vetulus*; the antennæ are very narrow and curved in a lateral as well as posterior direction; the second or swimming-antennæ are long as in other members of the genus; *macula nigra* present but small; eye small; post-abdomen short, triangular; claws pectinate; a dorsal sucking-disc is present;

length $\frac{10}{100}$ cm. For this species the name MACROTHRIX PAUPER is provisionally offered. (Plate VIII, fig. 1.)



(FIG. 6.)

MACROTHRIX TENUICORNIS, Kurz.

(FIG. 6.)

The description given by Kurz is very full and agrees very well. The peculiar arrangement of the movable spines at the margin of the valves is characteristic. I have observed that *this species forms an ephippium.* Müller says destinctly of the series of genera including *Macrothrix*, *Drepanothrix*, *Lathonura*, *Bosmina*, *Acantholebris and Iliocryptus*, "*Testae abjectæ corporis, nullo ephippio, ova hiberna obtegunt.*"

Bosmina is little related to the *Lyncodaphnidæ* and, however it may be with regard to other species, in *M. tenuicornis* an evident ephippium is formed in much the same way as in *Ceriodaphnia*. In *Daphnia* this egg-cover is produced by an alteration of part of the inner layer of the shell which becomes turgid and secretes a thick coating. The ephippium simply extends over the brood-cavity, being marked off from the rest of the shell by the median suture of the valves. In other *Daphnidæ* and in *Macrothrix* nearly the whole of the valves are thus modified. The shell of *M. tenuicornis* is normally smooth, but in the ephippial female, that portion of the inner layer of the shell bordering the egg-cavity and a little beyond, is composed of large and very deep cells; the space between the outer and inner layers is much greater than in *Daphnia*.

Genus LATHONURA.

Although no species of this genus has been found in Minnesota, it is to be expected that it will eventually be discovered that the cosmopolite *L. rectirostris*, Müll. occurs in our limits. It occurs in Mass. according to Birge. The figures (Plate VIII, figs. 11-12) were drawn from specimens found in Leipzig, Saxony, illustrating a tendency, especially common in the *Lyncodaphindæ*, to abnormal growth of the spinous appendages—in this case the anal setæ.

Genus ILIOCRYPTUS.

A genus represented by a single European species. Our form may differ somewhat in some respects from the generic diagnosis, but certainly belongs here. There are no anterior cœca (as indeed there are probably not in the European *I. sordidus* though so stated by Müller,) and no permanent cœcum or dilation of the intestine before the rectum. The marginal spines are straight, long and movable without branches.

ILIOCRYPTUS SPINIFER sp. nov.

(Plate VIII, figs. 2–6.)

Short; depth nearly equaling length of body excluding head; rounded behind; free edges of valves beset with slender ciliate spines which are not branched; antennæ exactly as those of *I. sordidus*, as is the post-abdomen, save that the anus seems to be situated higher; ova three or more.

This species occurs in Silver lake, east of Minneapolis. It swims quite well, while of the European species it is said this is not the case. It does, however, frequently load itself with filth so as to be too heavy to swim freely.

LYNCODAPHNIA, Gen. n.

(Plate IX, figs. 1-3.)

Form much as is species of *Alonella*, etc., truncate behind; superior antennæ like *Macrothrix*, attached movably to the end of a blunt prominence beneath the head; second or swimming antennæ slender; four-jointed ramus with three long setæ at the end of terminal joint where is also a stout spine; joint following the basal joint also with a spine above; middle joint unarmed (?); three-jointed ramus as in *Macrothrix*; the basal segment armed with a much elongated seta; eye relatively small; pigment fleck present; *intestine twice-convoluted*, expanded in front of colon, opening in the "heel" of the post-abdomen; post-abdomen slender, sub-triangular, margined behind with a double series of spines; terminal claws large, straightish and furnished with a long and short spine near the base, also very minutely feathered behind; shell marked alone by the so-called "stuzbalkein;" lower margin with movable spines.

Few more interesting forms have been noticed than this, since it combines the characters which have hitherto been considered as very clearly forming the boundaries of distinct families.

Kurz says, (*Dodekas neuer Cladoceren nebst einer kurzen Uebersicht der Cladocerenfauna Böhmens*, p. 30:) "Keine Cladocerenfamilie bildet eine so streng in sich abgegrenztes natürliches ganze, wie eben die Lynceiden," and this even after recognizing the relationship of *Macrothrix* and *Lathonura* to the Lynceids by placing them in the sub-family *Lyncodaphniæ*. The form for which I propose the name *Lyncodaphnia* is quite as much like such forms as *Alona* and related Lynceids, as any species of the *Lyncodaphninæ*, while at the same time the characters of antennæ and head are almost identical with *Macrothrix*. This furnishes but another example of the fact that possibility of distinguishing families and genera lies alone in the meagerness of our knowledge.

LYNCODAPHNIA MACROTHROIDES, sp. n.

Form sub-rectangular, greatly elongated; length $\frac{12}{100}$ cm., hight $\frac{5}{100}$ cm. or less; first antennæ long and slightly curved, bordered behind by about ten spines and terminating in two unequal sword-shaped spines and several sense-hairs, about $\frac{17}{1000}$ cm. long; swimming antennæ very slender as in *Macrothrix*, $\frac{6}{100}$ cm. long; head not marked off by a depression from the body, small and extending below into a blunt elevation for attachment of antennæ; labrum rather large; eye small; macula nigra conspicuous but not large; anterior feet strongly armed with curved spines. The intestine anteriorly is furnished with cœca, is twice convoluted, broadened before entering the rectum and opens a little distance beyond the oval seta in the heel of the post-abdomen; post-abdomen rather slender, toothed behind with a double series of about twelve prominences, becoming distally sharp, strong teeth; terminal claws curved at the end only, pectinate and bearing two unequal but large processes near the base; eggs much like those of *Macrothrix*.

Occurs in Lake Minnetonka, Hennepin Co., Minnesota, rare.

LYNCEIDÆ.

But few of this large family, furnishing the majority of the Cladocera fauna of any locality and at any time of year, have been carefully studied here. The following are mentioned as of particular interest:

SUB-FAMILY EURYCERCINÆ.

The single species *Eurycercus lamellatus* which constitutes this sub-family has been mentioned and figured in a previous paper. It is quite abundant and constant.

Eurycercus is connected with the true Lynceids by the following genus which has quite as many affinities with *Eurycercus* as any Lynceid. Schödler seems to be the only writer who has laid sufficient stress upon this similarity, though it may not be best to unite the two forms as he did.

Genus LEYDIGIA, Kurz.

LEYDIGIA QUADRANGULARIS, Leydig.

(Plate VIII, 7-8.)

The Minnesota species is referred to *L. quadrangularis* under the belief that there is no specific distinction between that species and *L. acanthoceroides*, Fischer.

Our form does not agree in every particular with the very minute description of Kurz and does agree very well w th what is said of *L. acanthocercoides*. However, Kurz says of the latter species, "Diese Art is von der vorangehenden (*L. acanthocercoides*) im weiblichen Geschlecht schwierig zu unterscheiden," and immediately adds that the male is unknown to him. In P. E. Müller's time both males were unknown. Müller says of *acanthocercoides*, "ungues caudales inermes," of *quadrangularis*, "ungues caudales dente minuto." Kurz on the other hand says of the former, "der Basaldorn ist kurz," of the latter "die Endklauen haben keinen Basaldorn."

Our species has no spine on the claws, and has a small spine on an eminence on the dorsal part of the abdomen, as well as two ciliated prominences between it and the oval setæ; length $\frac{9}{10}$ cm.; color red.

Silver Lake, east of Minneapolis.

CAMPTOCERCUS MACROURUS.

(Plate X, fig. 9.)

This large species occurs rather sparingly at Lake Minnetonka. It is probably .widely distributed in America as well as Europe. It is known in Cambridge, Mass. and Madison, Wis. (Birge).

CAMPTOCERCUS ROTUNDUS, sp. nov.

(Plate VIII, figs. 9–10.)

Short, quadrangular, dorsally nearly uniformly arched; antennæ of first pair long, curved outward, with long terminal bristles; abdomen long, nearly uniform in width; teeth of post-abdomen few, inconspicuous; terminal claw nearly straight; basal spine large; the claw also has a series of spines beginning a little beyond the middle and shortening proximally; length $\frac{7}{100}$ cm. This resembles *C. rectirostris*, Schödler, a little in outline of body but the head is like *C. macrourus*, except that there is a slight beak directed anteriorly (not shown in the figure); the post-abdomen is much as in *C. macrourus*, but is less heavily spined. In size it is somewhat less than *C. lilljeborgii*, and the shortest species known to me.

ACROPERUS sp?

(Plate X, fig. 10.)

Resembles *Camptocercus macrourus* greatly. Are these two genera really distinct?

PLEUROXIS PROCURVUS, Birge.

(Plate X, fig. 6)

Very characteristic. Found in Shady Oak lake, and elsewhere abundant.

PLEUROXIS UNIDENS, Birge.

A species which agrees best with this is quite abundant. It is, however, always of a deep brownish color, and the beak is long and curved inward; it may be distinct.

A third form of *Pleuroxis*, probably *P. denticulatus*, Birge, is abundant also.

GRAPTOLEBRIS INERMIS, Birge.

(Plate X, figs. 8, 11–12.)

Resembles *Alona testudinaria* very closely; the antennæ are peculiar; each joint has a median circlet of fine bristles; the upper ramus is terminated by two long setæ, one shorter seta and a stout spine; the joint preceding the terminal one has a stout seta. The description given by Birge is otherwise complete. Lake Minnetonka.

CREPIDOCERCUS SETIGER, Birge.

This is exceedingly rare, and by reason of its small size, difficult to distinguish. It has been encountered but once in Minnesota. This species is easily recognized when found, and though our specimens differ a little from the figure given by Birge, they are doubtless the same.

ALONA OBLONGA, P. E. Müller.

The specimens examined differ somewhat from Müller's description. The caudal claw is pectinate; the spine at its base is large and covered with a tuft of hairs; the teeth of post-abdomen are large, emarginate and hairy; otherwise the agreement is very close; length .07 cm. Found in Grass Lake, Richfield.

TRIBE III ONYCHOPODA.

POLYPHEMIDÆ.

POLYPHEMUS PEDICULUS.

(Plate IX, figs. 4–6.)

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Weismann, Beitr. z. Naturg, d. Daphnoiden.
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I have collected from various sources what I could of the extensive bibliography of this, the sole species of the genus. One of the most characteristic and pleasing figures given is that of Weismann in his article on the "Schmuckfarben der Daphnoiden," though we believe that author in the wrong in the deductions made. Our specimens rarely approach the brilliancy of the plate, and there seems to be a more legitimate way of explaining these secondary colors than by sexual selection. This species is never abundant, nor is it very rare; found in Lake Minnetonka, and the larger lakes with their outlets.

III *On Notadromas and Cambarus.*

CYPRIDÆ.

This group is one of the most difficult and perhaps least studied. A number of species some of which, perhaps most, are new, occur in Minnesota, and among them is a *Cypris* which exceeds any described form in size. I only mention one genus which is cosmopolitan.

NOTADROMAS, Lilljeborg.

Carapace differing in male and female; eyes two; antennæ similar to those of *Cypris*, the superior having seven and the inferior six joints; setæ of inferior antennæ reaching beyond the apex of the terminal claws; second pair of jaws without a branched appendage, in the male pediform; abdominal rami rather long.

NOTADROMAS MONACHUS, Müller.

Bibliography.

Cypris monacha, *Muller, Latreille, Bosc, Demorest, Baird. Edwards.*
Monoculus monachus, *Gmelin, Manuel. Fabricius, Rees, Jurine.*
Notodromas monachus, *Lilljeborg*, De Crust. ex ord. trib.
Brady, British Ostracoda.

Females of this widely distributed species were collected near Minneapolis, presenting in as far as could be seen no material points of distinction from English types.

DECAPODA.

But two species of *Cambarus*, *C. virilis.* Hagen, and *C. signifer*, occur in Hennepin county, except, perhaps, in the Mississippi. The following localities for the former species are known in the State: Mississippi river, Minnehaha creek, Bassett's creek, Cedar lake, Lake Minnetonka, Lake Independence, Lake Superior.

It is possible to recognize three age-forms in the males of this species.

A. The immature male (II Form, Hagen). Reaching two to three inches in length, this stage has the chelæ proportionally smaller, and the spinous armature less developed; the first abdominal foot is simply bifid at the end.

B. (Form I of Hagen,) usually over two and one-half inches long; chelæ larger; branches of abdominal foot destinct; inner branch grooved but lance-linear.

C. Very large (four inches); inner branch of abdominal foot spatulate at end; the two rows of tubercles on the inner margin of the "hand" with six or seven in a row instead of five.

Male of Form II, A stage, 2½ in. long, Chela. 7 in., thumb .49 in.
" " I, B stage, 2½ in. long, " 1 in., " .6 in.
" " I, C stage, 4 in. long, " 1.8 in., " 1.1 in.
" " II, A stage, 3 in. long, " 1.2 in., " .75 in.

It will be seen from the above that size does not govern the transition from the first to the second form entirely. This differs either in different localities or at different seasons of the year. A large gathering from Cedar lake showed no specimens of the form I, while a similar gathering at Lake Independence contained but one of the form II. A male from Minnehaha creek had rudiments of a third tooth on the carpus of the left claw, thus indicating an approach to Hagen's Var A.

CAMBARUS SIGNIFER sp. nov.

(FIG. 7.)

A slender, graceful species of rather marked colors, belonging to the section having a hook on the third pair of legs but not on the fourth. The rostrum is not carinated nor toothed at the apex; acumen moderate, lateral borders curved, moderately excavated. Cephalothorax arched and not depressed above, densely punctate; areola linear; chelae slender, straight; thumb deeply excavated on the inner margin for the proximal one-third; opposite finger with an impressed groove on the inner but not on the outer margin.

Male, I Form. Color reddish-(crimson) brown, not obviously figured; tail lighter; fin chestnut, marked with gray; chelæ bright crimson below there are green markings on the body and legs, and some yellow below.

The hands are rather narrow and straight, while the "thumb" is deeply excavated for one-third its length, and the notch thus formed is armed with three or four teeth; the finger opposite has a tooth half way from the apex, and others near the base; the ange at base of thumb is densely hairy. The penultimate and previous joint of second foot bears a very dense and thick tuft of hairs on the inner margin which it particularly noticeable in living specimens. The antennæ are short about as long as the thorax when reflexed.

The first pair of abdominal feet resemble those of *C. virilis* somewhat, but are stouter and less divided. They are more strongly curved than in *C. propinquus.*

The laminæ of antennæ are much as in *C. troglodyles* but wider at the base.

The second form has the two branches of the abdominal foot united almost to the end. The young males have the chelæ greenish-blue and mottled, while the coloration of the body is like the females.

The females have shorter chelæ, and broader abdomen marked with chestnut bars on each segment above.

A male 3.3 in. long was still in form II, while another 3.2 in. long was in the form I. Found by hundreds in a shallow pool known as Grass Lake, in Richfield, Hen. Co.

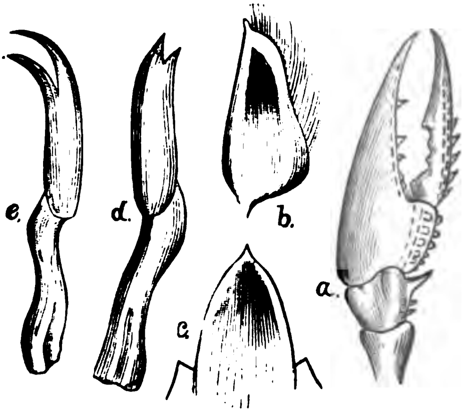

Fig. 7.
Cambarus signifer.
a chela. *b* lamina of antenna. *c* rostrum. *d* abdominal foot of form II. *e* abdominal foot of form I.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

THE FIRST ANNUAL REPORT OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1872. 8vo. 112 pp , with a colored geological map of the State. *By N. H. Winchell.* Published in the Regents' Report for 1872. Out of print.

THE SECOND ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF THE STATE, FOR THE YEAR 1873. *By N. H. Winchell and S F. Peckham.* Regents' Report; 148 pp. 8vo., with illustrations.

THE THIRD ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1874. 41 pp. 8vo., with two county maps. *By N. H. Winchell.* Published in the Regents' Report for 1874.

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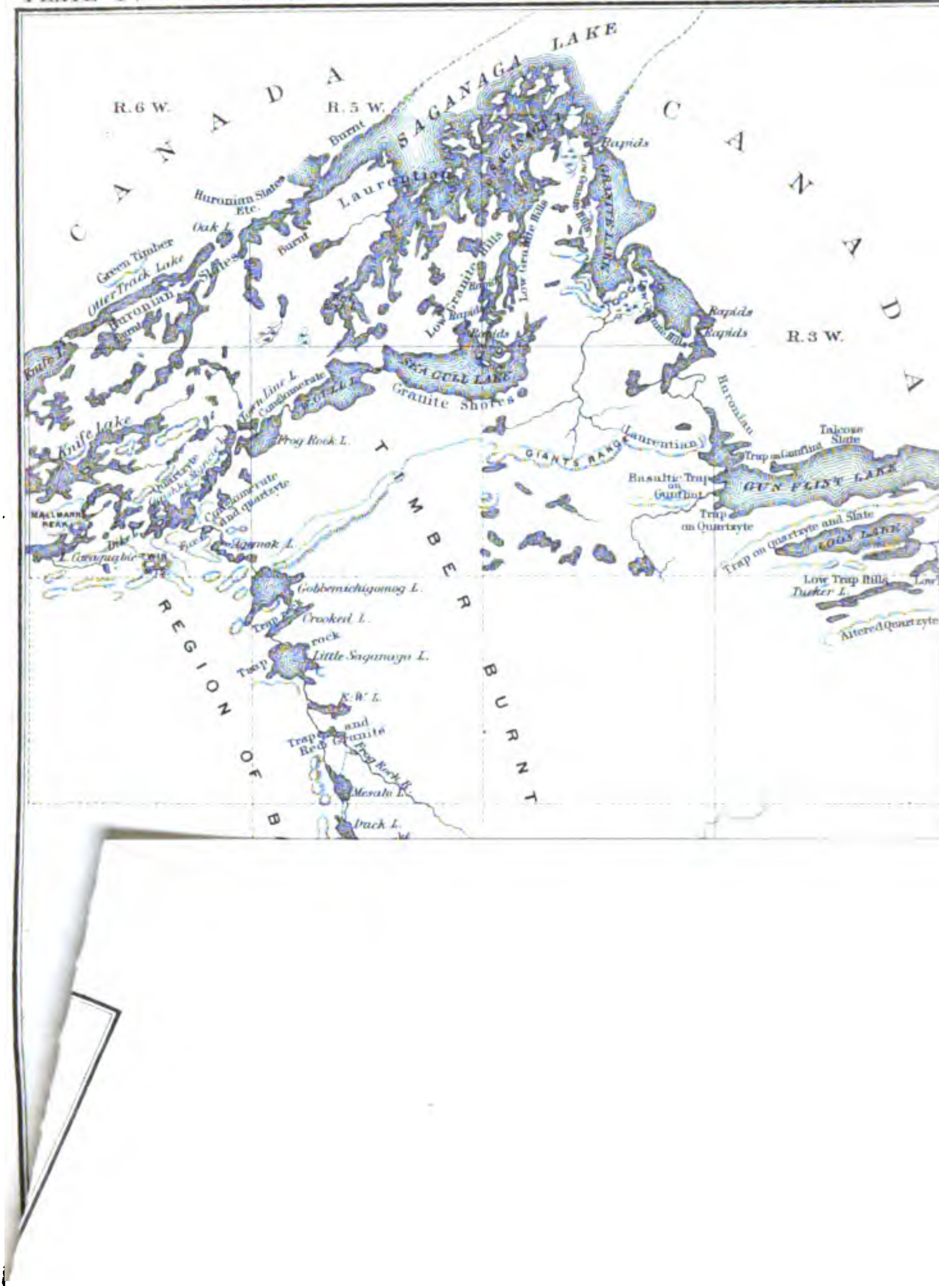
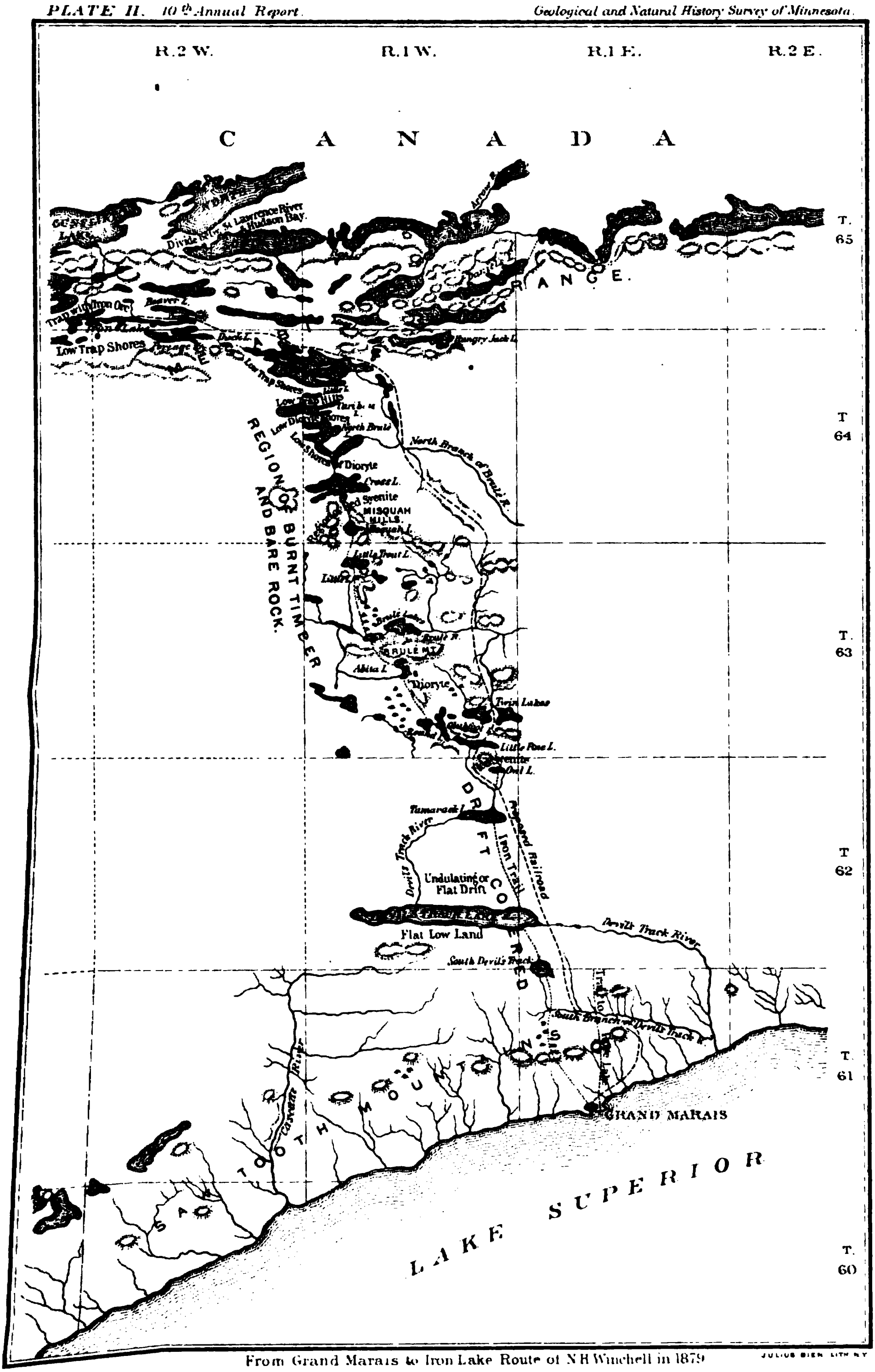
10. CIRCULAR No. 6. To owners of mills and unimproved water powers. Relating to the Hydrology and water-powers of Minnesota. 1880.

ERRATA.

Page 42. Third line—for *sawthuth*, read Sawteeth.
56. Twelfth line—for *tubes*, read talus.
65. Twenty-third line—for *tract*, read trail.
67. Seventeenth line—for *vein*, read rim.
89. Twelfth line—for *land*, read hand.
99. Twenty-fourth line—for *Merabi*, read Mesabi.
119. Twenty-ninth line—after *trilobite*, add a foot note, as follows: **Conocephalites minor Shu.?*
133. Twenty-sixth line—for *conspicuous*, read calciferous.
134. Fifth line from the bottom—for *Sendrogroptus*, read *Dendrograptus*.
147. Twenty-sixth line—for *oppressed*, read appressed.
175. Sixth line—after *p.* 417, add in 1871.
187. Thirtieth line—for *have*, read has.
191. Eleventh line—for *steepry*, read steeply.
239. Fifteenth line—for *apicata*, read *spicata*.

PLATE I. 10th Annual Report Geological and Natural History Survey of Minnesota





From Grand Marais to Iron Lake Route of N H Winchell in 1879

JULIUS BIEN LITH N.Y.

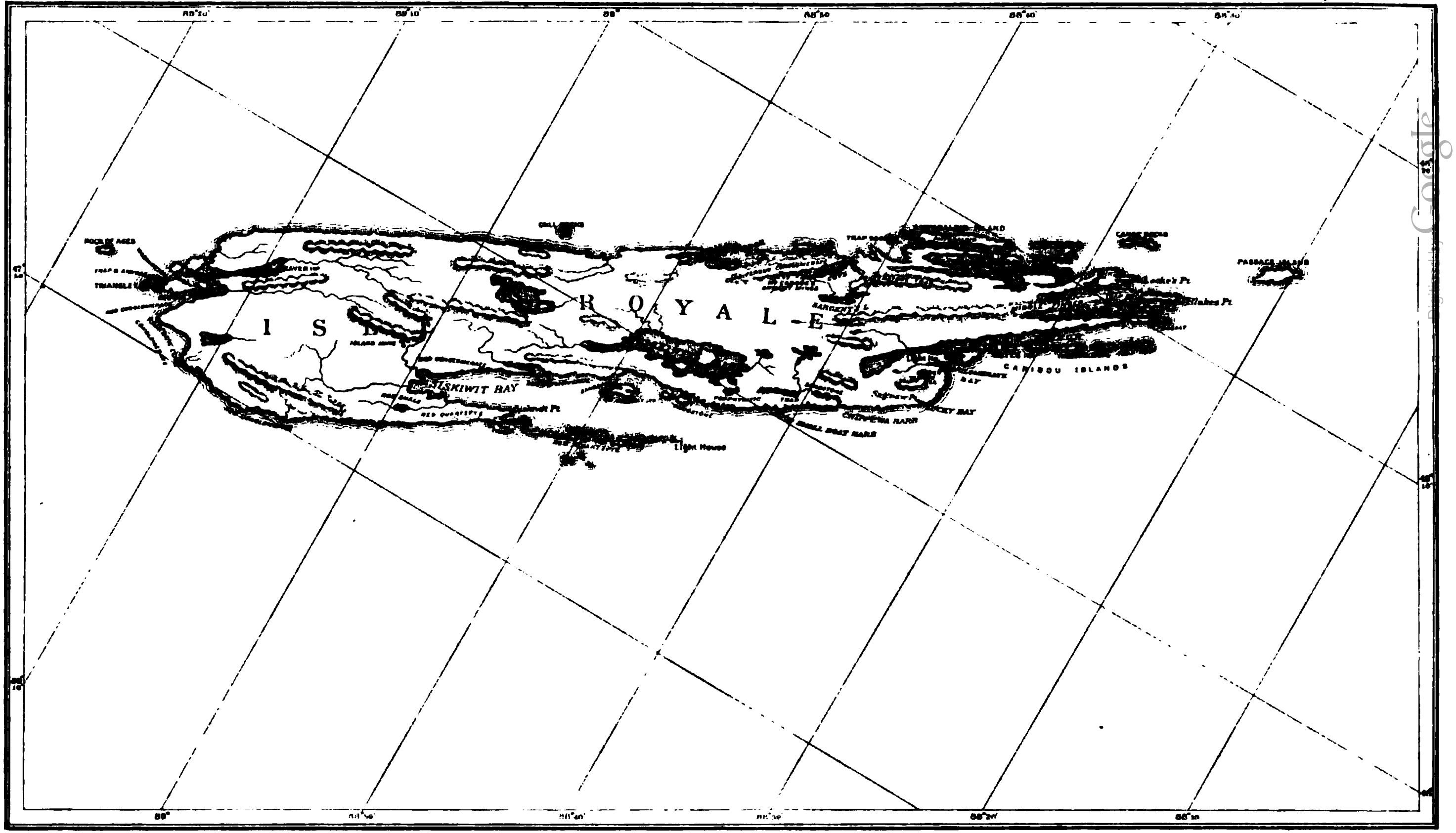
PLATE III.

Sketch Map of Isle Royale.

To illustrate notes on the Geology by N. H. Winchell in 1879.

PLATE III. 10th Annual Report

Geological and Natural History Survey of Minnesota



Julius Bien, lith. N.Y.

PLATE I.

Diaptomus castor.

1. Male, antennæ not yet fully developed, showing shell, gland, heart, reproductive, alimentary and muscular systems.
2. Female, antennæ and appendages removed except fifth feet.

3 and 4. Nauplius stage.

5. Male foot of fifth pair, (a) "thumb" of larger branch.
6. Female foot of fifth pair.
7. Mouth parts etc.

MINNESOTA . CRUSTACEA.

PLATE I.

10th Annual Report *Geol. & Nat. Hist. Sur. Minn.*

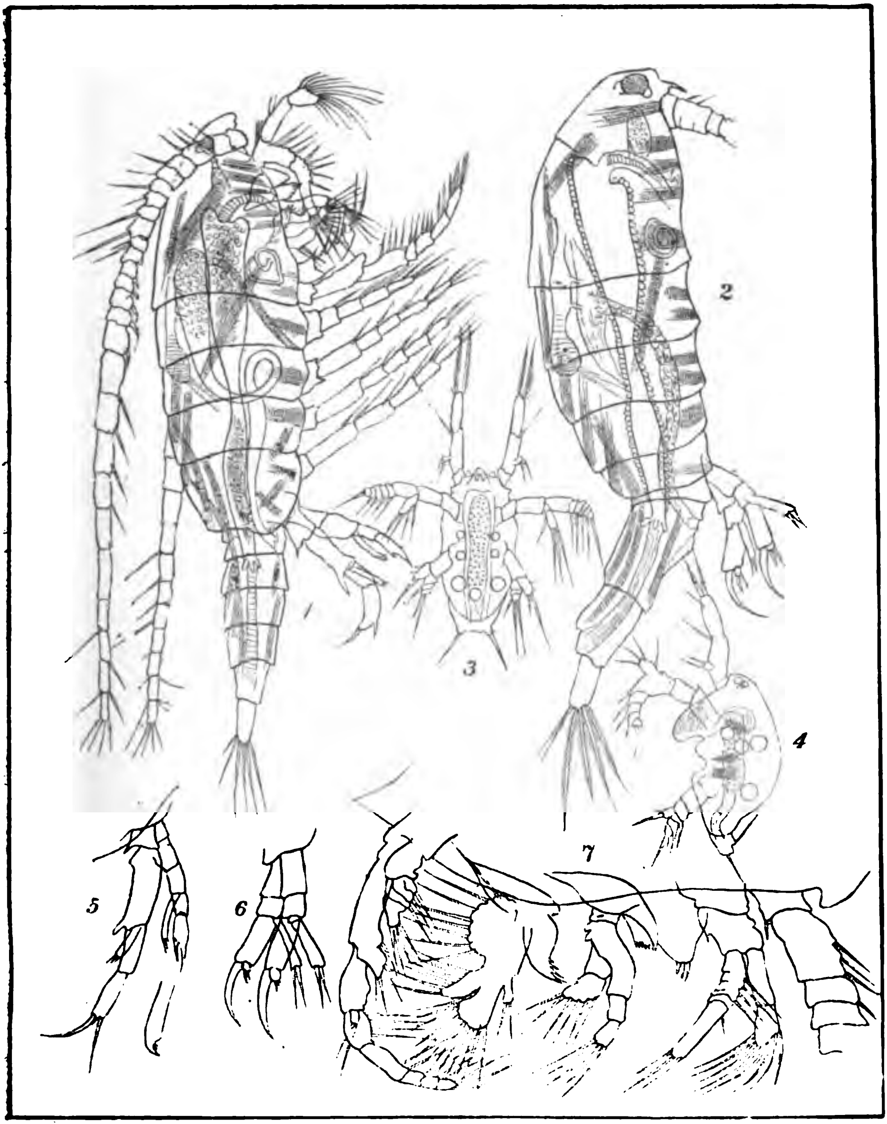


PLATE II.

Diaptomus castor.

1. End of male antennæ.
2. End of abdomen.

Diaptomus giganteus.

3. Caudal stylet.
4. One pair of feet.
5. Maxilliped.
6. Maxilla.
7. Mandible and palp.
8. Antennule.
9. Male fifth foot.
10. Female fifth foot.
11. Spermatic tube.

Potomoichetor fucosus.

12. Female fifth foot.
13. Female abdomen and egg-sac.
14. Abdomen of young.
15. First foot of *Diaptomus giganteus*, one branch drawn reverse.
16. " " *castor*, " " "

MINNESOTA CRUSTACEA.

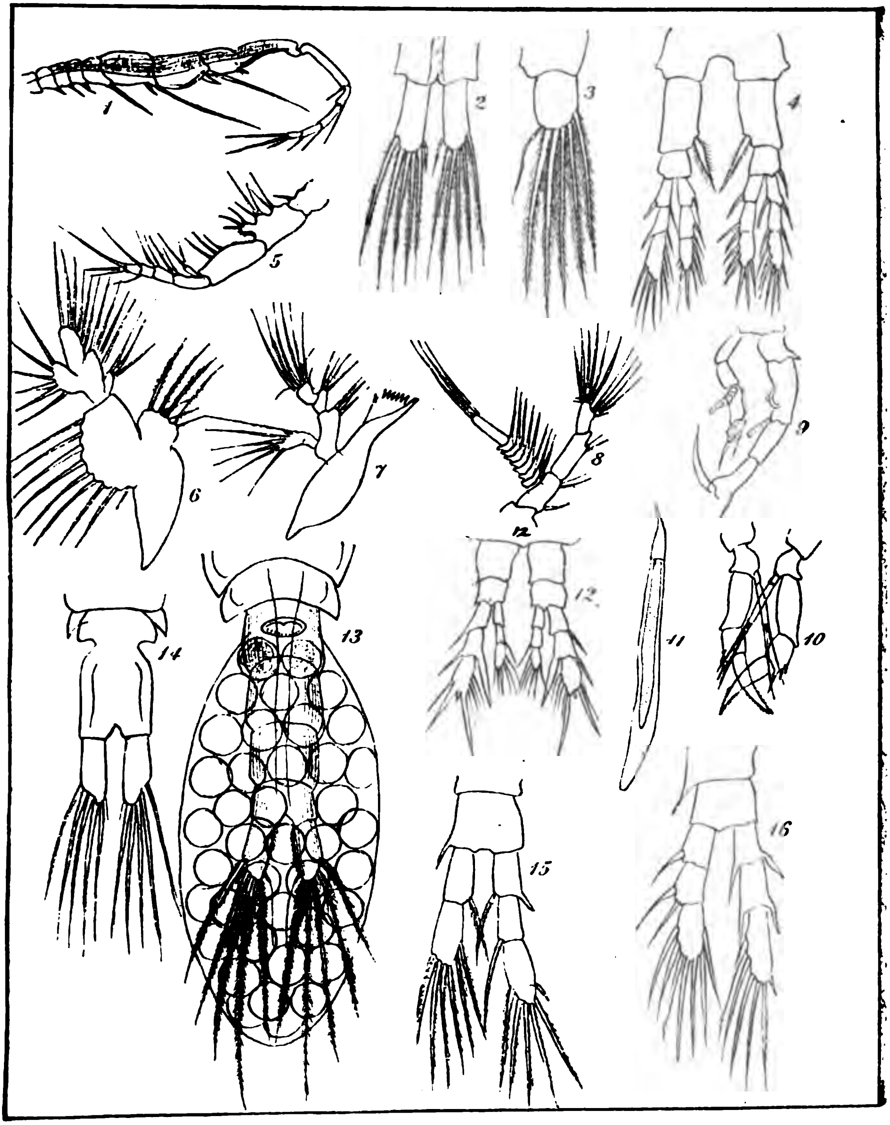


PLATE III.

Potomoichetor fucosus.

1. Male.
2. Antennule.
3. Maxilliped.
4. Male fifth pair of feet.
5. Palp of mandible.
6. End of abdomen.
7. Feet of first pair.
8. Eye.

Cyclops ater.

9. Female
10. Abdomen.
11. Maxilliped
12. Antenna.
13. Maxilla of *Potomoichetor fucosus.*
14. Mandible of " "

MINNESOTA CRUSTACEA.

PLATE III.

10th Annual Report

Geol. & Nat. Hist. Sur. Minn.

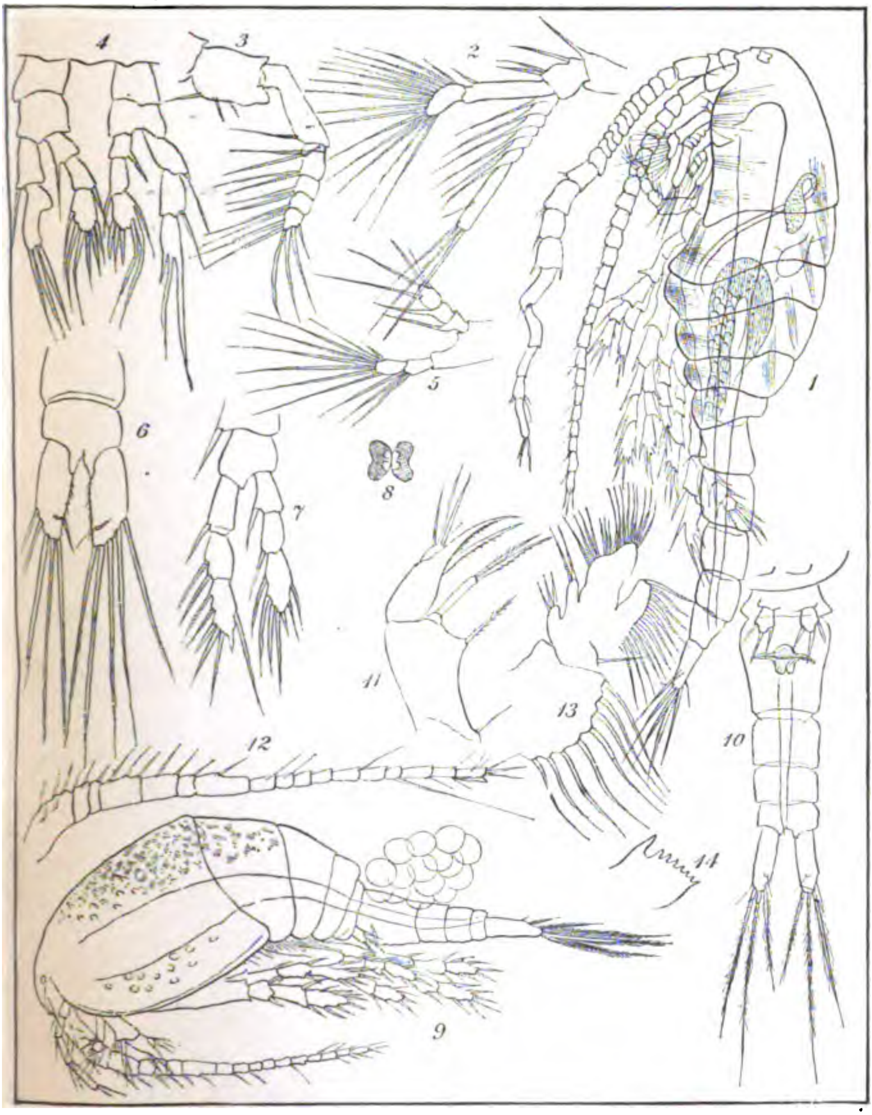


PLATE IV.

Cyclops ingens.

1. First segment of abdomen of female.
2. Antenna.
3. Fifth foot.
4. Antenna of young male.
5. Stylets of mature female.
6. " young male.
7. Maxilliped.
8. Mandible.

9. *Cyclops crassicornis*, Female.

10. Antenna.
11. Terminal portion of abdomen.
12. Female fifth foot.
13. Second antenna.
14. Nauplius form.

MINNESOTA CRUSTACEA.

PLATE IV.

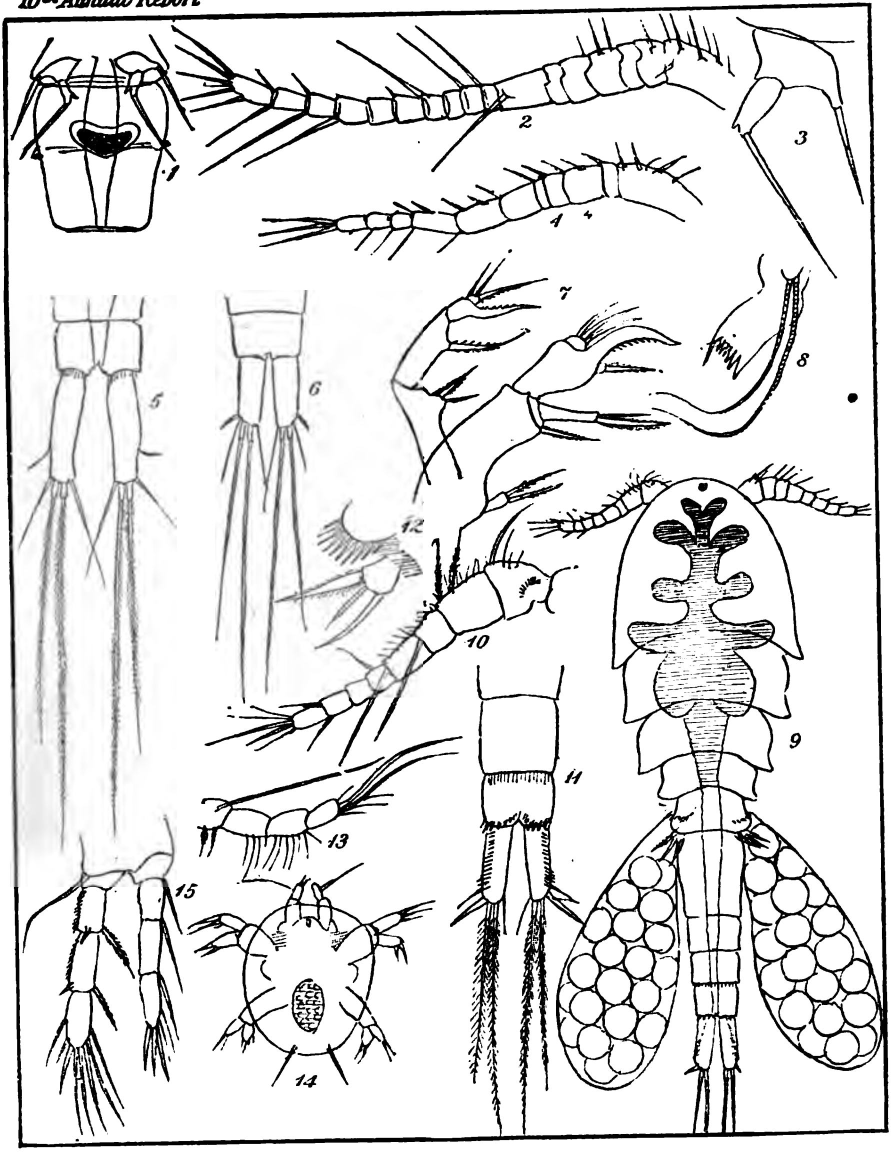


PLATE V.

Cyclops serrulatus.

1. Female.
2. Antenna of elongated form.
3. Stylet of ordinary form.
4. Antenna of very young.
5. Stylet of elongated form.

6. *Cyclops navus*, antenna.

7. Furca.
8. Abdomen of young.
9. Abdomen of male.
10 Opening of spermatophore.
11. Fifth foot.
12. Antenna of young.
13. " male.
14 *C.* "*signatus*," maxilliped.
15. *C. navus*, swimming foot of first pair.
16. " " " second pair.
17. Maxillipeds.

MINNESOTA CRUSTACEA.

10th Annual Report

PLATE V.

Geol. & Nat. Hist. Sur. Minn.

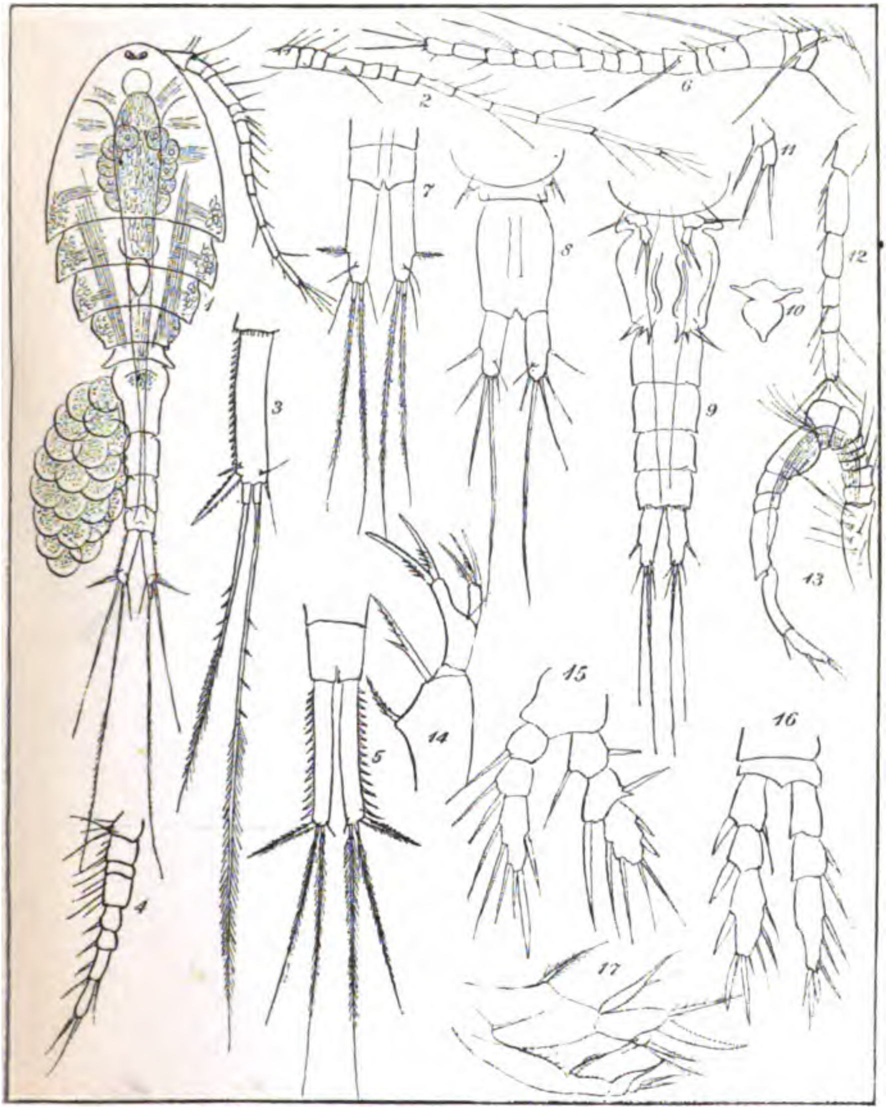


PLATE VI.

Cyclops tenuicornis.

1. Female.
2. Mandible
3. Maxillæ.
4. Stylet.
5. Fifth foot.
6. Maxillipeds.
7. Antennule.

C. "*signatus.*"

8. Abdomen.
9. Antenna.
10. Fifth foot.
11. Male antenna.

Cyclops parvus.

12. Abdomen.
13. Antenna
1 . Fifth foot.

Cyclops adolescens.

15. Opening of spermatophore.
16. Abdomen.
17. Foot.
18. Female antenna.
19. Eye.
20. Male antenna.
21. End of antenna of a form of *C.* "*signatus.*"

MINNESOTA CRUSTACEA

10th Annual Report

PLATE VI.

Geol. & Nat. Hist. Sur. M

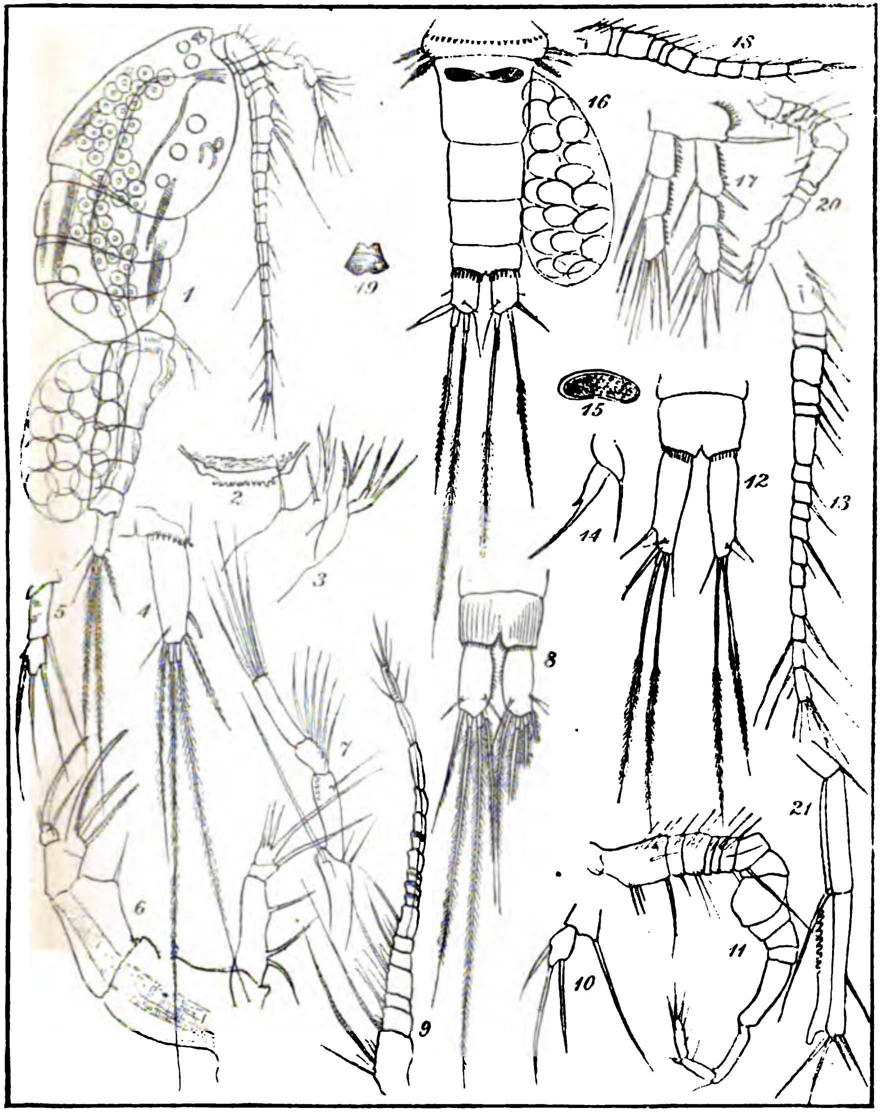


PLATE VII.

1-9. *Cyclops fluvialitis.*

3. Antenna of young. 4. Abdomen of young. 10. Young of *C. serrulatus.*

11. *Daphnella brachyura*, female. 14. End of male abdomen.

12. " " male. 15. End of female abdomen.

13. Part of edge of valves. 16. Antenna of male.

MINNESOTA CRUSTACEA.

10th Annual Report PLATE VII. Geol. & Nat. Hist. Sur. Minn.

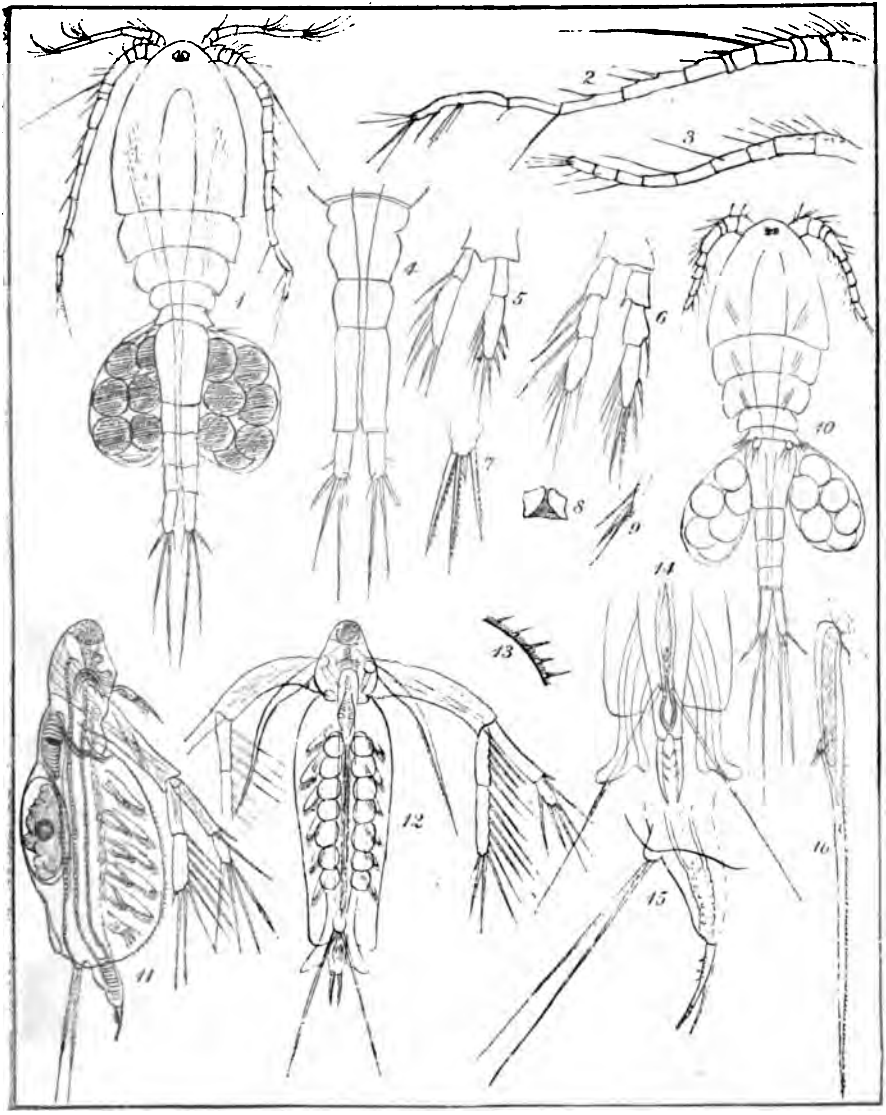


PLATE VIII.

1. *Macrothrix pauper*,
2–6. *Iliocryptus spinifer*.
7–8. *Leydigia quadrangularis*
9–10. *Camptocercus rotundus*.
11–12. *Lathonura rectirostris*.

MINNESOTA CRUSTACEA.

PLATE VIII.

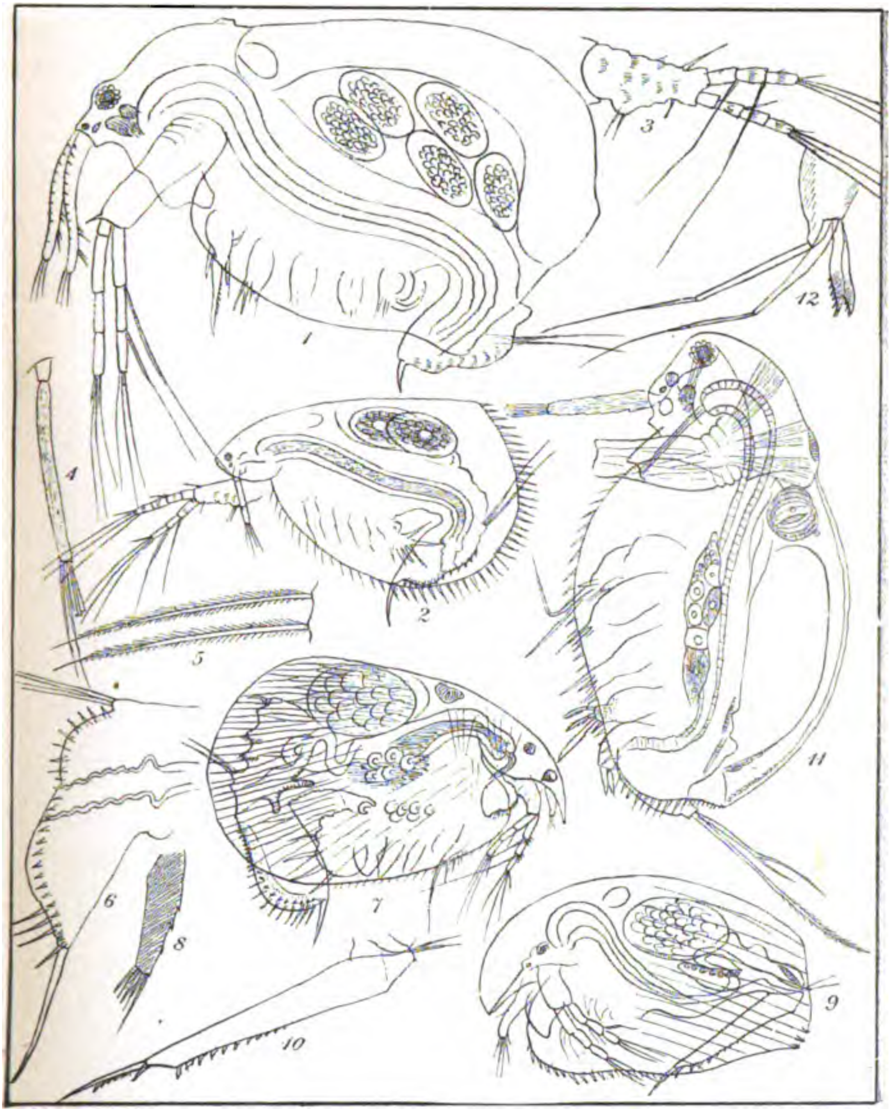


PLATE IX.

1–3. *Lyncodaphnia macrothroides.* 4–6. *Polyphemus pediculus*

MINNESOTA CRUSTACEA.

PLATE IX.

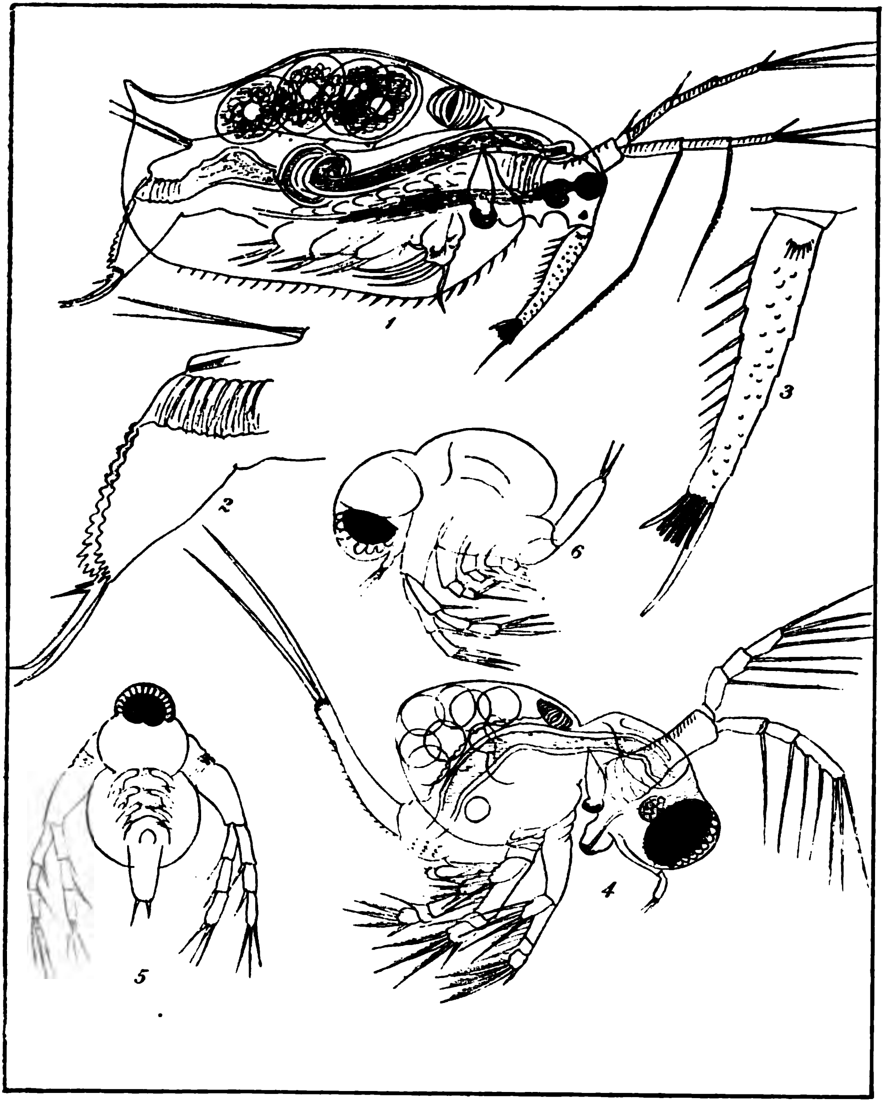


PLATE X.

1. *Bosmina striata.*
2. “ *longirostris.*
3-5. “ *cornuta.*
6-7. *Pleuroxis procurvatus.*
8. *Graptolebris inermis.*
10. *Acroperus sp?*
11-12. *Graptolebris inermis.*

MINNESOTA CRUSTACEA.

PLATE X.

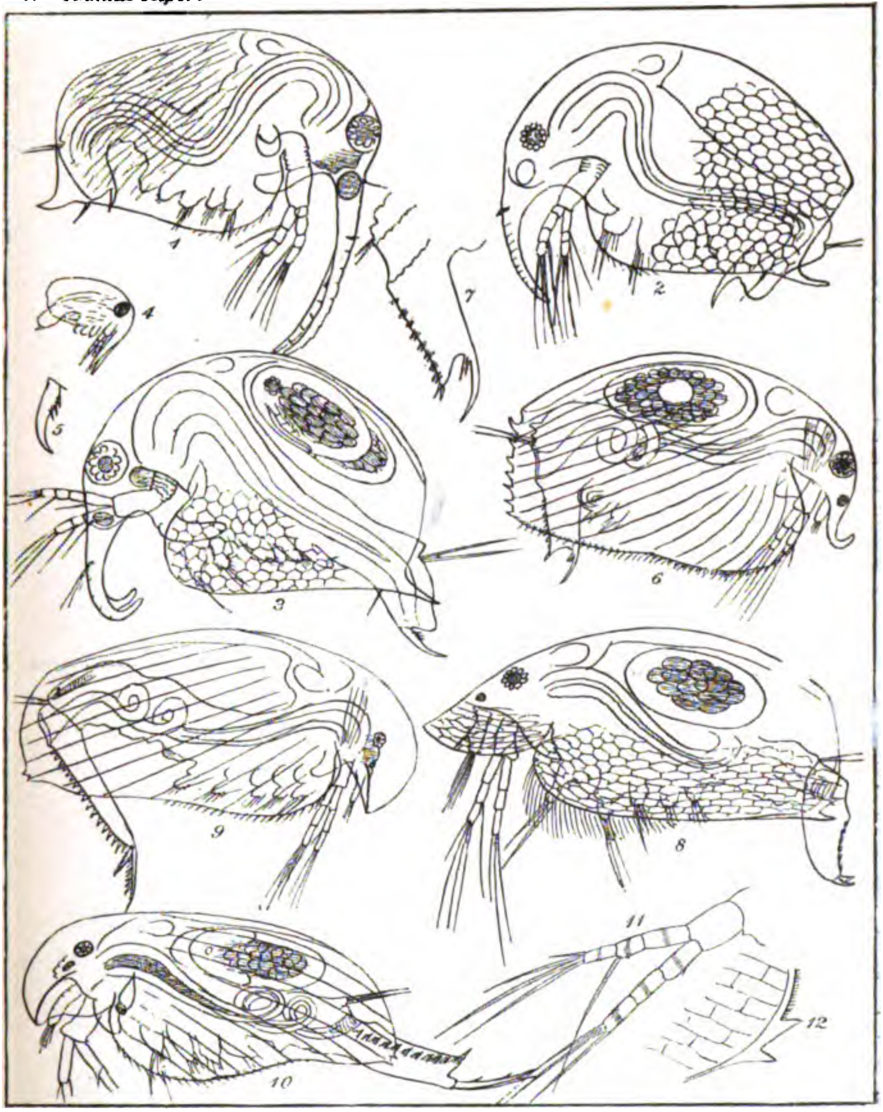
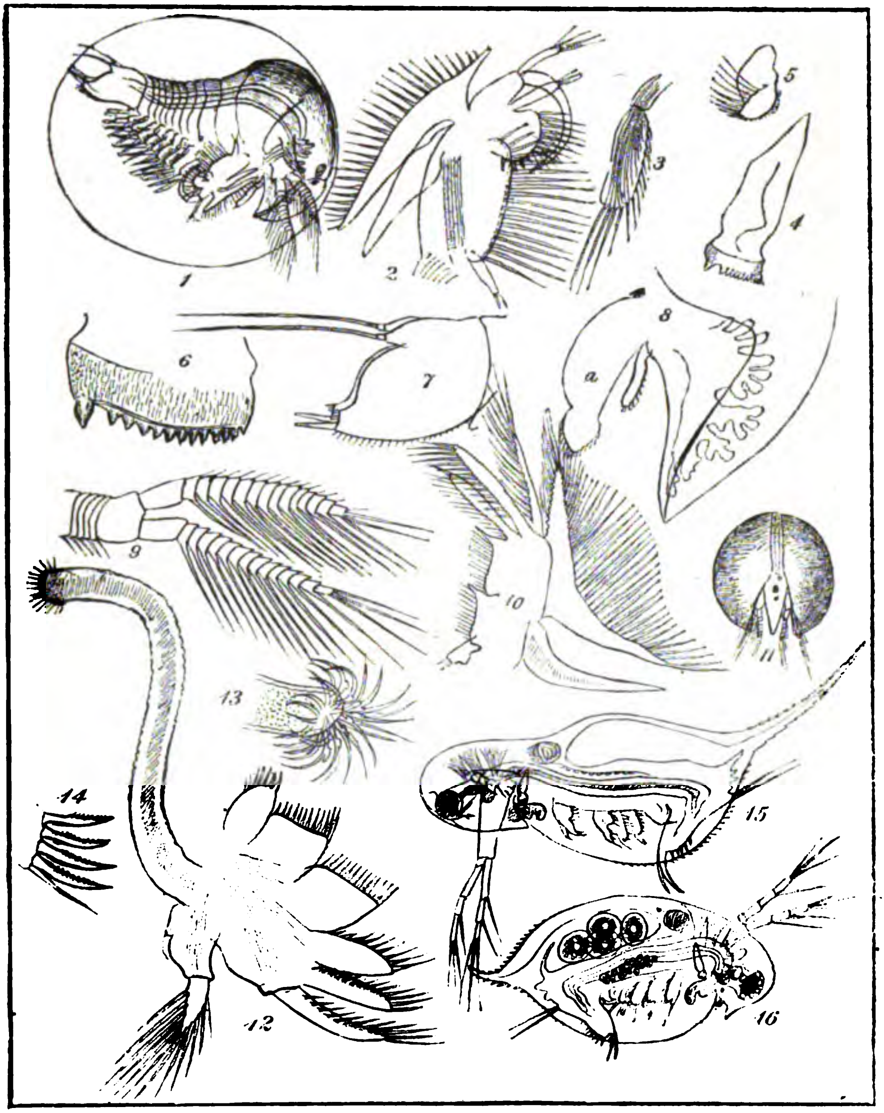


PLATE XI.

1. *Limnetes* sp ? male.
2. First foot of male.
3. Antenna.
4. Mandible.
5. Maxilla.
6. Mandibler teeth.
7. Caudal appendages of female.
8. Head, labrum etc., of female.
9. Antenna (2d) of female.
10. Foot of female.
11. Exterior of whole animal from in front.
12. Modified (sexually) foot of female.
13. End of process of same.
14. Magnified spines of lateral limbs of same.
15. Daphni sp. ?
16. Daphni sp. ?

MINNESOTA CRUSTACEA.

PLATE XI.



GEOL.
LAB.
557.9
M6

GEOL.
LAB.
557.9.
M6

THE
GEOLOGICAL
AND
NATURAL HISTORY SURVEY
OF
MINNESOTA.

THE ELEVENTH ANNUAL REPORT,

FOR THE YEAR 1882.

N. H. WINCHELL, STATE GEOLOGIST.

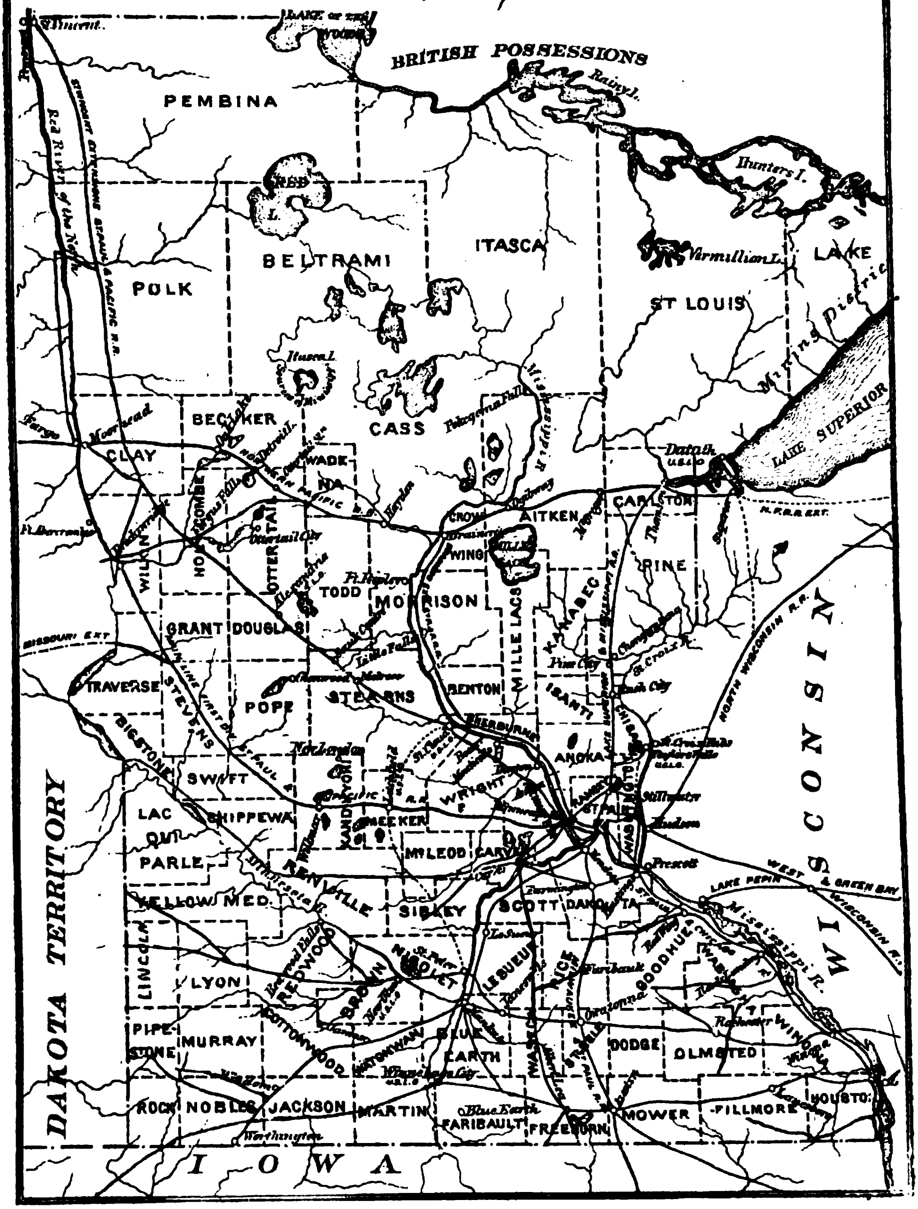
Submitted to the President of the University May 21, 1883.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON,
1884.

MAP OF MINNESOTA.

Showing the Location of the Counties.

Total area 84,286 square miles.



I. C. Russell.
compliments of
W J McGee.

THE
GEOLOGICAL
AND
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ADDRESS.

To the President of the University:

I present herewith the eleventh annual report on the progress of the geological and natural history survey of the state. In the year 1882 the only field-work done was that performed by myself in the counties of Winona, Wabasha and Dakota, and the report thereon will be included in the first volume of the final report, now in press. The accompanying report embraces important matters coming within the purview of the survey in the northern part of the state, that have as yet only partially been worked up, and hence does not really embody the work of the year in full, a considerable portion of which has been devoted to maps and manuscripts on the southern and western counties.

Respectfully submitted,

N. H. WINCHELL,

State geologist and curator of the general museum.

MAY 21, 1883.

REPORT.

I.

THE MINERALOGY OF MINNESOTA.

[A report read before the Minnesota Academy of Natural Sciences, October, 1882.]

BY N. H. WINCHELL.

During the year no special effort has been made to further a knowledge of the mineralogy of the state by this committee. But some advance has been made by the publication of work that had been done before by others. The committee has not had any meetings. This is partly due to the absence of the chairman, and partly to his neglect when not absent. The section consists of N. H. Winchell, T. B. Walker, A. F. Elliot, C. W. Hall, J. A. Dodge, A. H. Pearson, N. Butler, R. J. Baldwin and M. A. Morey.

In the inception of any systematic and thorough work on the mineralogy of Minnesota it is obvious that the first thing to do is to find out what has been done already. It is the object of this paper to accomplish that for the Academy. In other words this paper begins with a reference to publications on the minerals of the state so far as they can now be ascertained — a kind of *bibliography of the mineralogy of Minnesota* — and ends with an enumeration of such minerals as are known to occur in the state, and a statement of their localities, with notes on their characters and peculiarities.

151505

Bibliography of the mineralogy of Minnesota.

The earliest mention of any minerals in Minnesota is to be found in the Relations of the Jesuit missionaries. The pious and venturesome fathers occasionally mention metallic copper in possession of the Indians, and in some cases attempt to give some idea of the whereabouts of the mines from which it was obtained, but their statements are of little scientific value. La Harpe's "History of Louisiana" mentions that Le Sueur saw a large mass of native copper near the mouth of a small lake at a point four leagues above the mouth of the St. Croix river. One of the early maps locates a coal mine on the Minnesota river some distance above its mouth. Le Sueur's fanciful copper-mining took place in 1700 and 1701 and was located at fort L'Huillier, near the mouth of the Blue Earth river. Carver in his "Travels" first alludes to the "red marble," of which the Indians made their calumets, now known as *catlinite*, and to various black, white and blue clays found in the same part of Minnesota.

Prof. Wm. Keating, however, in 1823 seems to have been the first to have identified any minerals by recognized and accepted scientific terms within the limits of Minnesota. This was during his expedition with major Stephen H. Long to the "source of the St. Peter's river and to lake Winnipeek," wherein he acted as geologist, mineralogist and general chronicler. It is true that major Long in 1817 in his narrative of a "Voyage in a six-oared skiff to the falls of St. Anthony" had enumerated sundry brilliant pebbles which he had gathered on the summit of Gwinn's bluff, in Winona county, saying they consisted of "*crystals of iron ore*, *siliceous crystallizations* beautifully tinged with iron, some of them purple, others reddish, yellow, white etc., crusts of sandstone strongly cemented with iron, and I think set with *solid crystals of quartz*;" and again at a point a few miles below the mouth of the St. Croix he mentions a bluff which he ascended on the slopes of which he observed a variety of pebbles and stones amongst which were the *agate* of various hues, *chalcedony*, *flint*, *serpentine*, *ruby* and *rock crystals*, etc.; but as major Long was not a mineralogist while Keating was, it will do Long no injustice to accredit the first accurate mineralogical observations to Keating.

His first observations were on the sands that compose the banks of the Mississippi below St. Paul (vol. 1, p. 304). He remarks that in these sands sometimes are found "carnelians, agates, jaspers, etc., which present characteristics analogous to those observed on the Rhine below Oberstein, and in Scotland where they are distinguished by the name of Scotch pebbles."

* * * * "In one or two instances while examining the sand with a miscroscope, a white transparent topaz with its dihedral summit, could be well made out."

At the mouth of the Redwood river, Keating enumerates *quartz*, *feldspar*, *mica* and *amphibole*, and dwells on the great variety of combinations which they assume in, the primitive rocks there *in situ*. At the lake of the Woods he mentions *iron pyrites* and veins of quartz; and on the authority of Dr. Bigsby, staurolite is said to occur in the slates of Rainy Lake river.

Mr. Featherstonhaugh mentions galena not far from Red Wing; salt springs east of the Pembina hills; and bituminous coal at lake Traverse.

Mr. George Catlin, whose work on Indian costumes and manners is well known, visited the famed red pipestone quarry in 1836, and was the first to procure and bring away for chemical examination a piece of the pipestone. This he submitted to Prof C. T. Jackson, of Boston, who gave it the name of *catlinite*, though Gen. H. H. Sibley insists that the Indian name (e-yan-shah) should be preserved. (Journal of the council of Minnesota 1849, p. 30.) The paper of Mr. Catlin is published in the American Journal, (1) XXXVIII, though it was read before the Boston Society of Natural History, Sept. 4th, 1839. Dr. Jackson's analysis is in the 35th vol. of the American Journal, p. 388. Of this pipestone the following analyses by Prof. Peckham have been published in the *sixth annual report of the geological and natural history survey of Minnesota*, p. 101.

	Silica	Alumina	Iron	Manganese	Magnesia	Lime	Alkalies	Water
Jackson,	48.20	28.20	5.00	0.60	6.00	2.60		8.40
Peckham, (light-colored)	58.25	35.90	trace	—	—	—		6.48
Peckham, (red)	57.43	25 94	8.70	—	trace	trace		7 44

The geological survey of Wisconsin, Iowa and Minnesota, by Dr. D. D. Owen, added largely to the accurate mineralogy of the state of Minnesota. This was carried on from 1847 to 1850. As we shall have occasion to refer considerably to this in the enumeration of the minerals of the state, as well as to some of the following publications, it is sufficient here simply to name them.

In Schoolcraft's volume giving an account of the final discovery of the source of the Mississippi in 1831 and 1832 is a short list by Mr. Schoolcraft of localities of minerals observed in the Northwest in 1831 and 1832. Among these localities are named the following in Minnesota:

Calcareous tufa in the gorge below the falls of St. Anthony.

Granular quartz, falls of Pokegama, upper Mississippi.

Agate, imbedded in trap-rocks of lake Superior.

Hornblende, as a constituent of the primitive rocks of the upper Mississippi.

Argillite, St. Louis river.

In Schoolcraft's volume entitled "Summary narrative of the discovery of the sources of the Mississippi," published in 1854. by Lippincott, of Philadelphia, may be found a report (p. 356) by Mr. Schoolcraft, to John C. Calhoun, secretary of war, on the geology and mineralogy of the region of the upper Mississippi, bearing date 1822. This report seems to have been published first in 1854. In giving a description of the pipestone, now generally known as *catlinite*, he applies the true mineral name *opwagonite*, saying it is the Algonquin word for calumet-stone or pipe-stone. Realizing that this Algonquin word is more appropriate than that applied by Dr. Jackson, and supposing that Schoolcraft's references would bear out his implied earlier use of this designation, I took the trouble to consult his earlier reports to which he refers with a view to the adoption of Schoolcraft's name should it prove to have antedated the word *catlinite*. But it was found that in his "View of the lead mines of Missouri," published in 1819, to which he refers, he does not make use of that designation, and is so far ignorant of the origin of the substance as to assign it to the Falls of St. Anthony. Again, when in 1820 he visited the falls of St. Anthony, he corrects, it is true, his statement that it is found here, and assigns it to the coteau des prairies, but still does not employ the term *opwagonite* in the report of that expedition, published under the title, *Narrative-journal of travels from Detroit northwest through the great chain of lakes to the source of the Mississippi river in 1820*, as a member of the expedition under governor Lewis Cass. It seems to be necessary, therefore, to conclude that Schoolcraft invented the word in 1854, and published it as if applied in 1822. If Mr. Schoolcraft made such a mineralogical report to Mr. Calhoun in 1822, it is remarkable that it was not published, nor referred to by him in his volume on the discovery of lake Itasca, published in 1834 by Harper & Bros.

Mr. Schoolcraft, in 1854, also enumerates the following minerals and mineral localities in Minnesota:

Iron-sand, on the shores of Fond du Lac, lake Superior.

Micaceous ioxide of iron, among the debris of the St. Louis river, and of Fond du Lac.

Ochery red oxide of iron, "Is produced near the spot called Big Stone lake on the head of the St. Peter's river." It was employed as a pigment by the Indians.

Quartz is mentioned in various forms:

Arenaceous, the sandrock of many localities.

Pseudomorphous, shores of lake Pepin; having taken the crystalline impress and form of rhombohedral crystals of carbonate of lime.

Chcalcedony, shores of lake Pepin.

Carnelian, shores of the upper Mississippi.

Agate, shores of the upper Mississippi.

Basanite, (touchstone) along the banks of the upper Mississippi.

Mica,—in minute foliæ—in alluvial soil of the upper Mississippi.

Hornblende, at the "peace rock" on the upper Mississippi.

[This is in section 27, Watab.—N. H. W.]

Granular graphite, in a small vein in the clay slate of the St. Louis river, at the head of the nine-mile portage. It is coarse-grained and gritty.

Besides an occasional mention of native copper, gold, magnetic iron ore, coal and argentiferous galena, in the reports of the early so-called surveys of the state and territory of Minnesota, most of which are exaggerated for ambitious and speculative purposes, but little is added, in these reports, to the mineralogy of the state. Their authority and much of their material are taken from Owen's earlier *Report on the Geology of Wisconsin, Iowa and Minnesota.*

They may be enumerated, however, in the bibliography of the state; viz., *Report on Geology*, No. 12 of the legislative documents of 1861, Anderson & Clark. 26 pp., 8 vo.

Report of Hanchett and Clark on the geology and physical geography of the northwestern district of Minnesota. 1865, 82 pp., 8vo.

Report of H. H. Eames on the metalliferous region bordering on lake Superior. 1865, 23 pp., 8vo.

Geological reconnoissance of the northern, middle and other counties of Minnesota, by H. H. Eames. 1866, 58 pp., 8vo.

Geology and Minerals. Report of explorations in the mineral regions of Minnesota, in the years 1848, 1859 and 1864, by Col. Charles Whittlesey. 1866, 54 pp., 8vo. This phamphlet is more valuable for its geology than its mineralogy. Its errors are numerous, among which may be mentioned its identification of prehnite at French river with quartz, and of labradorite feldspar at Split-rock river with quartz. The summit of Carlton's peak is said to consist of gray quartz.

The following statement is quoted from this pamphlet, p. 41: "In the spring of 1858 a boulder was found on the north shore of the St. Louis river, at Rice's point below Oneota, having a metallic appearance, with a pale brass color, and which weighed about 100 pounds. Various accounts have been current as to the locality of this mass. Mr. R. B. Carlton said it was found by Joe Pose soon after the spring freshet, in the sand at the place just named. In size it is about a foot long, with two faces nearly parallel, as though it came from a vein with regular walls, four or five inches wide. Some persons regarded it as an artificial alloy of zinc and copper, which had been produced by melting a church bell. It is broken with difficulty, and in the interior has patches of a greenish tinge. The mass has a whitish-yellow color, a pyritous aspect, finely crystallized with small blotches of spar, showing it to be not an artificial compound. As I was sending a box of minerals to my friend, J. H. Boalt, Esq., of the School of Mines at Freyburg, in Germany, a piece of this boulder was forwarded, with the request that it should be analyzed. The arsenides of copper were then unknown on lake Superior, but I have since seen a specimen from Portage lake. Mr. Boalt reported that about the time of the arrival of my specimen, another was received from Chili, in South America. All parties were interested to know what ore of copper they represented. The analysis gave 83 per cent. of metallic copper and 17 of arseni, which approaches very near to the rare mineral, *algodonite* of Dana. The boulder, no doubt, came with the drift materials from the northeast, and represents a vein somewhere in that direction, perhaps not far distant."

In the *Minnesota Teacher* for June and July, 1871, Mr. J. H. Kloos has papers on *Geological rambles in Minnesota*, in which are found some discriminating remarks on the minerals constituting the crystalline rocks near Duluth. He mentions:—

Labradorite,
Diallage or hypersthene, or augite,
Magnetite,
Epidote,
Calcite,
Laumontite,
Chlorite,
Quartz,
Copper.

At Taylor's Falls he enumerates:—

Hornblende,
A transparent mineral of the color of chrysolite,
Labradorite,
Copper,
Dolomite,
Quartz,
Calcite,
Copper glance,
Earthy malachite.

In the syenites of the St. Cloud region he also enumerates the minerals which he expects to find on making a careful chemical and mineralogical examination, viz:

Orthoclase,
A triclinic feldspar,
Pyroxene,
Labradorite,
Anorthite,
Hyperite,
Hornblende,
Mica,
Protobarite,
Pyrite,
Quartz.

Mr. Kloos collected samples of some of the crystalline rocks, which he took to Germany. These were the subject of a series of papers by Streng and Kloos in the *Neues Jahrbuch fur Mineralogie* (Geol. u. Pal.) 1877. Mr. Kloos repeated his general observations, and extended them, in a paper published in 1871 in the *Zeitschrift d. d. geol. Gesell.*, p. 425.*

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*A translation of the latter may be seen in the tenth annual report of the survey, 1881.

Minerals and mineral localities in Minnesota.

NATIVE ELEMENTS.

GOLD.

Gold has been washed from the drift in noticeable quantities in various places in the state, particularly at Rochester, Oronoco, Spring Valley, sec. 31, Jordan, Fillmore county, and at several points in Wabasha county. As an ingredient of the bedded rocks it has been sought in the chloritic slates at Vermilion lake as reported by Mr. Eames in 1865, and somewhat in the same formation west of Moose Lake station in Carlton county. In these examinations, the former of which induced a general movement of miners and other hasty speculators to Vermilion lake, some gold may have been found if the assays published in Mr. Eames' report be true. Recent assays, however, do not give gold in any appreciable amount from the Vermilion quartz rocks nor from the slates containing the quartz veins.

Gold has lately been taken from the gravel at Willmar, as reported. The pieces are angular and appear to have been recently cut by some sharp instrument, indicating an artificial sprinkling in the naturally rounded gravel. It is 91 per cent. pure gold, the rest being copper. Gold is also found in the quartz veins of Rainy lake, but the shafts sunk have all been on Canadian territory, so far as I am informed.

SILVER.

Silver occurs native in the quartz veins of the slates in the northeastern part of the state, but no valuable deposits within Minnesota have yet been brought to light. This is the same formation that is wrought at Silver Islet and Thunder bay in Canada. Its most abundant occurrence is in the form of argentiferous galena. Several late enterprises have begun operations in the islands between Thunder bay and Pigeon river and one also is started on one of the islands south of Pigeon point, in Minnesota. Some of the float pieces of copper found in the central and northern part of the state also show small quantities of silver. The assays of the Vermilion gold ores reported by Mr. Eames show a small percentage of silver.

COPPER.

Copper has been mined at French river, at Snake river, at Sucker river, at Fall river, at Taylor's Falls, Chengwatana, and at several other points. At French river it occurs with prehnite and is occasionally associated with small quantities of native silver. This metal is disseminated in nodules and other vein-fillings throughout much of the trap-rock of the region, but is at the same time principally aggregated in one or two metalliferous beds, or belts; a shaft that penetrated 43 feet revealing two such beds. Pieces weighing several pounds have been taken from this shaft. At Chengwatana it has been sought by shafting in the trap and amygdaloids. Small particles have been found in the mineral thomsonite, which fills amygdaloidal cavities in the trap at Good Harbor.

Pieces of native copper of considerable size are occasionally found distributed through the drift in the central and southern parts of the state. Mr. T. Elwell, of Granite City, Morrison county, reports fifty-six pieces found in that vicinity, and transmitted to St. Paul, in 1861, by Hon. Levi Wheeler, representative from the third district. Several pieces have been found at Minneapolis and others at St. Paul. Numerous pieces have been found in the valley of the St. Croix; other localities are Rochester, Zumbrota, White Bear Lake, and along the Mississippi below St. Paul. Le Sueur is reported by La Harpe to have seen a large mass of native copper at a point four leagues above the mouth of the St. Croix river, near the mouth of a small lake. Several hundred pounds of float copper were found between the Northern Pacific Junction and Knife Falls, during the construction of the Knife Falls railroad. These pieces lay usually among stones on the surface, and were probably derived from the general drift-sheet that may be supposed to have covered the region, the railroad following the ancient valley of the St. Louis all the way.

IRON.

No well authenticated instance of native iron in Minnesota is known, though such has been reported from St. Paul. It is true that grains of metallic iron are found in the drillings of the well near the Harvester Works. These certainly are not natural. They have the form of iron cuttings and drillings artificially made and on being allowed to remain among the rock drillings become rusty immediately, cementing the rock grains in small rusty clusters. Their chemical composition also indicates that they are not natural.

GRAPHITE.

This is found in considerable quantities at Pigeon point. It is disseminated in lumps through a metamorphic sandrock. The lumps vary from the size of a pin-head to flattened masses six or eight inches in diameter. The sandrock sometimes becomes gneissic and is of the same formation as that which holds the silver mines of Thunder bay, and of Silver Islet. Graphite also exists in a vein about a foot thick a short distance above Thomson, at the head of the nine-mile portage. Schoolcraft says it is coarse-grained and gritty.

SIMPLE SULPHIDES, &c.

ALGODONITE.

This arsenide of copper was found in a large transported mass in 1858 on the shore of the St. Louis river near Rice's point. The piece was about a foot long, with two faces nearly parallel, although it came from a vein with regular walls four or five inches thick. It was reported to have been analyzed by J. H. Boalt of the School of Mines at Freiberg, Germany, and was found to afford 83 per cent of metallic copper with 17 per cent of arsenic.

WHITNEYITE.

On the authority of Mr. Dana, the large mass of algodonite last mentioned was stated to be partly made up of *whitneyite*, which is a compound of copper and arsenic, but having less arsenic than algodonite.

GALENITE.

This sulphide of lead is common in the state. It has been found almost invariably in the trial shafts for silver in the lake Superior region. It is associated with calcite, barite, pyrite and quartz. It is also found in limited quantities in the Galena limestone in the southern part of the state and in the St. Lawrence and St. Croix formations at Dresbach in Winona county. In the St. Croix sandstone at Dresbach it is found as a matrix which cements considerable masses of rock that is made up of sand grains and linguloid shells. In that form it has been taken out of a shaft about 20 feet below the level of the Mississippi river.

BORNITE.

This is probably the ore found by shafting, about 3 miles west of the mouth of Cascade river, lake Superior, and on the island south of Pigeon point. It also occurs in a dark bed of metamorphic conglomerate, about 6 feet thick, at London, near Duluth.

SPHALERITE.

This sulphide of zinc is common in the shafts sunk for silver in the slate and quartzyte group at Pigeon point and along the international boundary. It is also reported from Stillwater.

CHALCOCITE.

In a vein near the water level at St. Croix Falls, opposite Taylor's Falls.

PYRITE.

A common mineral. It occurs in all mines, and as nodules in most of the rocks of the state. It is found in the common building-stone (Trenton) at Minneapolis, as little shining yellow specks, and in the Cretaceous shales in the western part of the state. Sometimes it weathers out of the latter and is found on the sloping bluffs where these shales outcrop. It is also common in the blue drift-clay or hard-pan of the western part of the state, derived originally from the Cretaceous, and in that situation it retains its metallic lustre unchanged, affording frequent clusters of crystals that are quite beautiful. In some cases it seems to be indigenous in the drift-clay, in the same manner as selenite crystals.

CHALCOPYRITE.

Common in the shafts sunk in the cupriferous rocks in the northern part of the state—as well as in the slate and quartzyte group of Pigeon point.

MARCASITE.

Very common in the southeastern part of the state, where it accompanies the Cambrian limestones. It is found in lumps, partly altered to limonite, on the tops of the bluffs in that part of the state, along the river valleys. It is evidently the result of denudation from some higher strata.

COMPOUNDS OF CHLORINE.

HALITE.

The only evidence of this mineral in Minnesota is the occurrence of saline springs, and of artesian salt water in the northwestern part of the state. The most noteworthy instance is the deep well at St. Vincent, where, however, the brine contains also some lime and some magnesia.

COMPOUNDS OF FLUORINE.

FLUORITE.

This occurs in small quantities at Lester river, on the north shore of lake Superior, and in much larger quantities in some of the veins that have been explored for silver in the northeastern part of the state.

COMPOUNDS OF OXYGEN.

CUPRITE.

This mineral was observed, mingled with malachite, coating a piece of metallic copper which was found on the surface or among the drift materials, near Rochester. It doubtless also exists in varying quantities wherever metallic copper is found in the rocks of the state.

WATER.

Within the state there is a superficies of 5,637 square miles of water; and at Minneapolis the average flow of the Mississippi is 25,000 cubic feet per second. The average rainfall at Minneapolis is about 29 inches.

HÆMATITE.

This exists in large quantities in the vicinity of Vermilion lake and in the Mesabi range. It also occurs as a red, ocherous deposit in numerous places. It has been employed as a pigment by the Indians, who obtained it at Big Stone lake, at Grand Portage, lake Superior, and in the valley of the Blue Earth river.

MAGNETITE.

This is found in large quantities in the northeastern part of the state. It is apt to bear titanium, but when found in large strata in the Huronian formation, it is wholly, or nearly free from it. It occurs also at Rainy lake.

MENACCANITE.

This seems to be the principal magnetic mineral which enters nto the gabbro and other igneous rocks of the Cupriferous in Minnesota. It is so abundant in the region of Iron lake, north of Grand Marais, and at Herman, near Duluth, that it has attracted attention as an iron ore. The titanium present is frequently not enough to constitute this mineral, which requires from 30 to 40 per cent. It is sometimes as low as three per cent., the mineral then being rather titaniferous magnetite. As iron-sand it gathers on the lake Superior shore at Black beach, about four miles west of Beaver Bay, and can be extracted from the gravel with a magnet in nearly all parts of the state.

LIMONITE.

This ore of iron is frequently found pseudomorphous after pyrite and marcasite. This is particularly the case in the changed marcasite found in the southeastern part of the state. As a bog-ore it is found frequently, and it often stains the earth and the peat about lakes and stagnant pools, when it cannot, from its impurity, be styled correctly *limonite*. It is found as a bog-ore in considerable quantities near Coon creek, in Anoka county.

OXIDES OF THE CARBON-SILICON GROUP.

QUARTZ.

This most common of all minerals exhibits itself in nearly all its forms in Minnesota. Its most remarkable and pure deposits are seen in the St. Peter and St. Croix sandstones with which all geologists are familiar, in the bluffs of the Mississippi river and its tributaries, where it constitutes 98 per cent. of the rock. As agate, carnelian and chalcedony, it exists in the trap-rocks in the northeastern part of the state, and is distributed in the gravel throughout the eastern half of the state. Agate bay is so named from the great numbers of pebbles of agate that are found on its beach. But they are equally numerous in other places. Many may be found at Burlington bay and at the point next west of Knife island. As chalcedony it weathers out of the trap at Gooseberry river, and in the drift of the western part of the state it is in that form from fossil wood derived from the Cretaceous. It is less commonly found as amethyst in the Cupriferous, the only locality known in Minnesota, being on a small island a short distance east of Gooseberry river. Amethyst also occurs sometimes in the siliceous geodes of the Shakopee and St. Lawrence dolomites. As heliotrope or bloodstone, very fine specimens are sometimes found, but the prevailing color is brownish or black, rather than green. Moss-agate, which seems to come from agatized wood, is more common in the western part of the state, referable to the Cretaceous or Tertiary debris. Flint, hornstone, basanite, touchstone, red, brown and black jasper, as well as jasperoid hæmatite with beautiful banding, are common as pebbles throughout the state, particularly the eastern half. Agates and carnelians are so abundant that they are largely represented in every amateur collection, and thousands of specimens have been carried from the state. The amethysts that are sold so abundantly at Duluth are from Thunder bay, 150 miles further east on the north shore. Quartz occurs in perfect crystals in the quartz-porphyries on the north shore of lake Superior, in Minnesota, and in the form of prase it is found on the beach among the pebbles.

ANHYDROUS SILICATES.

HYPERSTHENE

Is a constituent of the rock at Black beach about four miles west of Beaver bay. Although this is the only point at which this silicate has been reported, though here subject to correction by more careful examination, it is probable that it occurs largely in the rocks of the north shore of lake Superior. It may be confounded with bronzite, since they show the same kind of metalloidal surfaces which glitter like mica in the sunlight. It has the same crystallization also.

*BRONZITE (ENSTATITE.)

The rock composing Encampment island on the north shore of lake Superior has a metalloidal augite as an important constituent, which is thought to be enstatite. It has, however, been examined only microscopically, and is subject to further analysis.

WOLLASTONITE.

A radiated white fibrous mineral from Scoville's point, Isle Royale, weathering from the trap of the region, is believed to be wollastonite, but the samples gathered have not been examined carefully. The same may be looked for in Minnesota between Grand Portage and Grand Marais, judging from the strike of the strata.

PYROXENE.

The only form of pyroxene within the state that has been identified is the variety known as augite ; and much of that belongs to the sub-variety diallage. It comprises a large constituent of the igneous rocks of the cupriferous, and is disseminated from Chengwatana to Pigeon point. The regular form of pyroxene seems to pervade the rock known as trap-rock at Taylor's Falls, but that is also subject to further examination.

SPODUMENE.

This may be doubtfully named as a Minnesota mineral from the Mesabi range.

AMPHIBOLE.

Under this name are included all the varieties of hornblende found in the syenites and crystalline schists of the state. This is a very common mineral. It is found in the St. Cloud and Sauk Rapids syenites, in the syenite near Duluth, and in the same formation back of Grand Marais. It is abundant in a rock at West Gull lake, near Saganaga, where it is associated with quartz and a little plagioclase so as to constitute a rock styled amphibolyte. The same rock spreads widely west of that point. Actinolite appears as a microscopic mineral in many thin-sections from the rocks of Minnesota. Both actinolite and tremolite are reported from Rainy lake by Dr. Bigsby.

CHRYSOLITE.

This mineral, which is common in the igneous rocks of the cupriferous series, as one of their constituents, sometimes makes, nearly alone, the entire rock. Such is the case in a rock on the iron trail north from Grand Marais, about half way between Little Trout lake and Brule river. (Sur. No. 677.)

GARNET.

Small garnets occur abundantly in the schists at Little Falls. Larger ones are in the same rock at Pike rapids, associated with staurolite. These are of the usual dark cinnamon color. But at Duluth in some of the metamorphic strata of the cupriferous is a wavy, honey-yellow garnet, pierced with microscopic actinolite. This is in small quantities in laminations in a metamorphic shale. (18 A.) Garnet occurs also at Rainy lake.

EPIDOTE.

A common mineral in the cupriferous rocks of lake Superior. It is known at Duluth, at Taylor's Falls, and abundantly on Isle Royale.

BIOTITE.

This is a common mineral in the syenites at St. Cloud, and as a microscopic mineral in the rocks of the cupriferous.

MUSCOVITE.

This is probably the mica that is mingled with the schists at Little Falls and at Thomson; and forms a constituent of most of the granites of the state. It is disseminated also through some of the sandstones, particularly the lower portions of the St. Croix at Dresbach. Along the northern boundary at Rainy lake and at lake of the Woods it has been seen in large foliæ.

WERNERITE.

This is found in the trap at the Island mine, Isle Royale, and doubtfully identified on the north shore of lake Superior at Lover's bay, in Minnesota. The form glaucolite is found also at the same place on Isle Royale.

ANORTHITE.

This accompanies orthoclase in the porphyries at Duluth and at Taylor's Falls.

LABRADORITE.

This the chief constituent of the Rice point gabbro, and of the range of hills that passes behind Duluth, and reaches to the international boundary. It forms the rock of Carlton's peak. It is embraced in basaltic trap at Split Rock point as transported light-colored boulders, making a curious pudding-stone. It occurs beautifully in large masses at Beaver Bay and constitutes low hills near the lake shore a few miles east of Beaver Bay. In some of these cases this mineral is nearly pure and makes up the whole rock. It does not, however, exhibit the internal opalescence, generally, which characterizes it in Labrador, and in Lewis county, New York. It is the chief feldspathic ingredient in the igneous rocks of the Cupriferous series.

ANDESITE.

This mineral occurs at Duluth, in the porphyries of the cupriferous.

ORTHOCLASE.

This is found abundantly disseminated porphyritically in the rocks at Duluth, and in the porphyry at Taylor's Falls, and is an essential ingredient in the granites everywhere in the state,—particularly those having a red color. It is perhaps as often found uniting with hornblende forming syenite, as with mica forming granite. It fills amygdaloidal cavities at Chester creek on the beach of lake Superior.

OLIGOCLASE.

This feldspar is found in an augitic quartz-dioryte at Watab, and in the syenitic granite at Sauk Rapids.

ALBITE.

It is disseminated porphyritically in some of the schists of the Huronian in the region about Vermilion lake, and is found also in the granite at Watab. A large boulder of chloritic schist, having crystals of albite ¾ inch across, was found by Dr. Elliot near lake Calhoun.

TOPAZ.

Occasionally occurs in the sand of the drift along the Mississippi below St. Panl.

DATOLITE.

Is found on Isle Royale, in the trap rocks, and is likely to be found in Minnesota, but has not yet been certainly identified.

STAUROLITE.

Is found in the mica schist at Pike rapids on the Mississippi, and at lake of the Woods in a similar rock, associated with garnet. At the former place the crystals are frequently twinned, at least crossed so as to make symmetrical cruciform figures, and some are attached obliquely. The schist disintegrates easily, allowing the crystals to mingle with the gravel where they are found sometimes in most perfect form and preservation.

HYDROUS SILICATES.

PECTOLITE.

Fine specimens of pectolite occur on Isle Royale, but it has not yet been identified with certainty in Minnesota.

LAUMONTITE.

This crumbling, flesh-colored mineral is very abundant in the Cupriferous rocks. It is not only found in the red amygdaloids, (or pseudo-amygdaloids) in which it pervades beds that reach a thickness of 1 to 15 feet, but is also found more sparsely disseminated in the amygdaloids of the trap itself. Its rapid disintegration when exposed to the weather is the first and most efficient cause of the many purgatories and arched rocks that beautify the scenery of the north shore of lake Superior. It is disseminated in these crumbling beds through a shaly rock of a red color, which often presents the characters of sedimentation, and even among the red conglomerates of the Cupriferous; these sedimentary beds showing fucoidal fossils.

CHRYSOCOLLA.

This occurs occasionally on the north shore of lake Superior and in the Cupriferous rocks of Pine county. It is generally associated with chalcopyrite.

PREHNITE.

At French river, containing native copper. It is here abundantly scattered through certain beds in all their cavities and veins, comprising. perhaps, one-tenth of the rock. It is radiated and fibrous, of a light color, slightly greenish in larger masses and appears like quartz, for which it has been mistaken. It is the gangue of native copper which has been taken out at French river.

CHLORASTROLITE.

At Rock Harbor, Isle Royale.

ZEOLITES.

THOMSONITE.

Of this section of the silicates probably the most noteworthy in Minnesota is the thomsonite which is found abundantly in the trap-rocks, from Terrace point to Poplar river, and even further west, on the north shore of lake Superior. It was brought to light by the Mayhew brothers of Grand Marais, who have bought of the squaws many hundred dollars worth gathered from the beach of the lake, where they are found smoothed by the waves among the gravel, thus showing their beautiful markings, and have sent them to eastern dealers in minerals and gems. Eclipse beach and Terrace point are the chief localities.

LINTONITE.

This is found associated with thomsonite, and seems to be a variety of that mineral. It is green, generally amorphous, and, although it frequently encloses the thomsonite amygdules, it also constitutes amygdules alone.

NATROLITE

Exists at Beaver Bay, on the north shore of lake Superior. It is in seams in the labradorite rock at the west point of the bay, and is taken out in crusts about ⅛ inch thick.

STILBITE

Is a zeolite common along the north shore of lake Superior, between Poplar river and Grand Marais. It occurs abundantly at Eclipse beach, and at Sugar Loaf point as far as Two Island river. It is also abundant about two miles west of Little Marais.

HEULANDITE

Occurs as coatings, very generally along the shore of lake Superior, in the joints of trap-rocks, according to the determination of Norwood. It is not certain but this mineral is the same as the next.

MORDENITE

Occurs with stilbite quite abundantly as amygdules on Sec. 29, T. 57, 6, a few miles west of Little Marais.

MARGAROPHYLLITES.

TALC.

This is the basis of the talcose schist, which plays a conspicuous part in the stratigraphy of the Huronian at Vermilion lake and on the International boundary; but no important deposits of the unmixed mineral have yet been discovered in Minnesota. It seems to be the chief ingredient in the greenish pipe-stone cut by the Indians from Pipe-stone rapids, and at Rainy lake.

GLAUCONITE

Is said to occur in the sandstones of the St. Croix, as at Red Wing and in the St. Lawrence limestone at St. Lawrence. But the characters of the Lower Silurian greensand do not agree with those of the Cretaceous greensand, nor with that from igneous rocks.

SAPONITE.

Under the name thalite, a mineral from the mouth of Knife river, was described by Dr. Owen as new to science, but Genth has shown it to belong under saponite. It is soft and nearly white, filling cavities in amygdaloidal rock at the very water's edge. It is also found in the same kind of rock on Kettle river, in Pine county. Owen regarded it, however, at the latter place, as a magnesian harmotome.

HALLOYSITE?

Whether the decomposed granites of the Minnesota valley can be included under this term or not, they certainly should be placed in this section of the silicates. The most of this deposit, which occurs characteristically at "Birch Cooley," is amorphous, earthy, soft, greenish and ferruginous on analysis; but in some places it is more nearly white, approaching kaolinite in outward characters.

DELESSITE.

Common as a product of decay in the trap-rocks of the north shore of lake Superior. It also fills amygdaloidal cavities and cracks. It gives a soft and slippery feel to the green traps when undergoing incipient decay near the water-line. It has a velvety radiated crystallization.

PROCHLORITE.

This term is here employed for all the chlorites and chlorite-like minerals that occur in the Cupriferons rocks, except delessite. Very often a chlorite-like mineral results from the decay of hornblende or augite. This is often called viridite, which signifies the same thing, but is used to avoid the appearance of exact knowledge of its mineral nature. The chlorite schists can hardly be distinguished from the talcose, and hardly from the hydro-mica schists without minute chemical or miscroscopic investigation. Hence it must be understood that the term here is used without intending to apply closely to that class of crystalline rocks, although there can be no doubt but the chloritic schists form an important group of the crystalline strata.

PHOSPHATES.

APATITE.

At present this is known only as an unimportant ingredient of the igneous rocks. It exists not only in the trappean beds of the

Cupriferous, where nearly every thin-section reveals, under the microscope, numerous needle-shaped crystals, but also in the igneous dykes that cut the rocks of the so-called Huronian at Thomson and the syenites of Sauk Rapids. The well known fertility of the soils derived directly from the decomposition of the igneous rocks seems to be due largely to the presence of this mineral.

SULPHATES.

BARITE.

Barite is common in the northern part of the state as a gangue rock in the veins that have been explored for silver and copper, particularly for silver. It is associated with calcite, pyrite, amethystine quartz and galenite. On Pigeon point is a conspicuous dyke or vein of white barite which crosses from one side of the peninsula to the other about one foot in width. This has long been known, having been described by Norwood, an assistant on Owen's survey.

GYPSUM.

This accompanies the Cretaceous rocks in the western part of the state and is found on the slopes of some of the bluffs made of the Cretaceous shales, as at Big Stone lake. It is frequently found in perfect, transparent, selenite crystals in the drift-clay in digging wells in the drifted western counties; where it seems to have been formed by segregation from the clay.

EPSOMITE.

On account of the easy solubility of this mineral it is not known to have been found in its crystalline condition in the state, but it is in solution in the alkaline waters of the western part of the state, in noticeable amounts. Mingled with some common salt it seems to have been the basis on which the so-called salt springs of the state were located. It is also found on the lower side of some projecting shelves of magnesian limestone, as a delicate white efflorescence, the sulphur being probably derived from oxidation of pyrite. This is the case along the bluffs of the Galena limestone at Mantorville

MELANTERITE.

This is also a product of the oxidation of pyrite or marcasite, and in limited quantities exists in the same situations as epsomite, as a coating on the under surface of projecting strata of dolomite, but its color is apt to be yellowish instead of white.

CHALCANTHITE.

This has not been identified in the state, but undoubtedly exists in the northern portion. It results from the oxidation of chalcopyrite and is apt to be carried away in solution by waters that come in contact with it.

CARBONATES.

CALCITE.

As the essential and principal ingredient of all limestones, this is an abundant and very important mineral in Minnesota. The only pure limestones, however, are those of the Trenton formation (the building-stone beds) as seen at Minneapolis and St. Paul, and the Niobrara limestone of the Cretaceous. So far as examined this contains a small percentage of carbonate of magnesia also; while all the others are highly magnesian, or quite dolomitic. Calcite also occurs in veins in the crystalline rocks, where it sometimes exhibits perfect crystalline forms. At Pigeon point some perfect specimens have been obtained in the shaft sunk by Kindred and Baker. At Crystal bay, near Duluth, a modified red shale has numerous nests of perfect crystals enveloped in a recent red clay, loosely embraced in cavities in the rock. Nail-headed and cockscomb forms of crystals occur in the Niobrara beds at Redstone, near New Ulm. At Chatfield some of the calcite in the Shakopee limestone embraces much quartz-sand in translucent grains, giving it the characters of the Fontainbleau limestone of France. Near Caledonia in Houston county is a large deposit of argentine or lamellar calcite, lying on the sloping bluff of the St. Peter sandstone. It has a grayish-yellow and brownish, undulating lamination varying to nearly white. A large piece of the same once existed near St. Charles, in a similar situation, but it has been exhausted for hand-specimens. Calcareous tufa or travertine is abundant in Minnesota, being the deposit of calcareous spring water. It has been mentioned on the east bluff of the Mississippi, just below the falls of St. Anthony, whence thousands of specimens have been removed by visitors. At Osceola, (or the St. Croix lake), calcareous tufa has been burnt for quicklime for forty years at least. Marl is sometimes found in swamps and beneath peat beds. Sometimes, as at St. Cloud, it shows its origin by containing, still, fragments of the fresh water shells from which it was derived. In other cases it is an impalpable, pulpy mud, which passes gradually into calcareous clay.

DOLOMITE.

This is the characteristic mineral of the dolomitic limestones of the state—and they include by far the greater number of our limestone strata. In its crystalline, pure form, dolomite is rarely seen separated from the rock-masses. Sometimes as brown spar it is seen lining cavities or associated with calcite in geodic aggregations, as at St. Lawrence.

ANKERITE.

This is simply a ferruginous dolomite, and has been reported only from the St. Lawrence limestone at Clear Grit, in Fillmore county, where it fills cavities in the limestone. It there has a slightly grayish color.

SIDERITE.

This is found in occasional loose boulders in the drift, more or less converted to limonite in the condition of clay iron-stone. In this form its origin is referable to either the Cretaceous (or Tertiary), or to the Devonian strata. Such lumps occur abundantly at Austin, and are easily recognized by their weight. In a purer state it has been found filling cavities in other boulders, somewhat in the form of an amygdaloid, the outer surfaces becoming spotted with limonitic depressions, due to the weathering out of the siderite after its conversion to an oxide. The boulders that are thus marked are quartzitic. As a pure carbonate it is found in important quantities in the iron strata of the Mesabi range, in northern Minnesota.

MALACHITE

Occurs sparingly in numerous instances in connection with the Cupriferous rocks of the state, in the lake Superior region. It is found also at Taylor's Falls and at Chengwatana, as coatings on the protected surfaces of seams in the rock.

HYDRO-CARBON COMPOUNDS.

MINERAL COAL.

That which is popularly known as "coal" in Minnesota and in Dakota, is lignite or "brown coal" from the Cretaceous, or from the Tertiary. It embraces not only impressions of woody fiber, but frequently considerable undecayed wood as well as charcoal, which shows the grain and cellular structure of the original wood. The best of it, however, is clean, black, amorphous and hard. On drying, this cracks in innumerable places and slowly crumbles to finer pieces, and these again to finer—a quality which renders it difficult to transport on cars or handle for fuel because of the waste. It occurs in the Cretaceous strata at Redwood Falls, on Crow creek, at Fort Ridgely, and on the Cottonwood river southwest of New Ulm, and has been found in the drift in nearly every county in the state. It also occurs at Namekan lake, on the northern boundary. These strata are frequently penetrated in sinking deep wells in western Minnesota and in Dakota.

II.

THE CRYSTALLINE ROCKS OF MINNESOTA.

By A. STRENG, of Giessen, and J. H. KLOOS, of Hanover.

[Extracted from the *Neues Jahrbuch für Mineralogie*, 1877.]

TRANSLATED BY N. H. WINCHELL.

The following work has been performed by us both, but in such a manner that the one who gathered the rock-samples has described the outward appearance and manner of stratification, and the other has labored on their mineralogical, microscopical and chemical investigation.

In respect to the nomenclature of the rocks, it should be remarked at the outset that it was not our intention to create new rock-species, and that consequently it became necessary, in the changing condition of petrography, brought about by the microscope, to select designations, which, it is true, are in accord with the old system of nomenclature hitherto used, but at the same time express, although briefly, that which distinguishes the rocks examined from those hitherto known. More extensive investigations only will be sufficient to determine whether the newly named rocks should be regarded as special rock-species or only as varieties of those to which they are most nearly related. If, for instance, a dioryte which, besides hornblende, contains an augitic mineral, shall be designated an *augite-dioryte* (if exact observations and investigations shall point to another dioryte) whether the presence of augite is a common property of dioryte, or whether it is limited to a few rocks, which, in that case, can be set off from the true diorytes as a distinct rock. We regard these names therefore only as provisional designations.

GENERAL DESCRIPTION OF THE APPEARANCE OF THE ROCKS.

The crystalline rocks which form the basis of this work were derived partly from the upper course of the Mississippi river, and one of its tributaries known as Sauk river, partly from the western extremity of lake Superior and near the mouth of the St. Louis river, and partly from the St. Croix river, on the boundary between the states of Minnesota and Wisconsin.

If one reach the shore of the great Mississippi above Prairie du Chien, in the state of Wisconsin, by any one of the railroads leading from the east, he notices immediately on both sides of the wide valley, perpendicular walls of sandstone which are capped with layers of dolomite of little thickness. These are the western representatives of the Lower Silurian formations named *Potsdam* and *Calciferous* sandstones in New York state. David Dale Owen has distinguished them, in his geological report for the year 1852, as *Lower sandstone of the upper Mississippi*, and *Lower Magnesian limestone.*

As one ascends the river toward the state of Minnesota, gradually the sandstone disappears, cut through in many ways by the streams and tributary rivers, so that by the time the St. Croix river is reached the banks consist entirely of layers of dolomitic limestone. These also have a slight northern dip, and give place, in the neighborhood of St. Paul, to the next higher members of the Silurian, the *St. Peter sandstone* and the *Upper Magnesian limestone.* The latter has been determined to be the undoubted equivalent of the *Trenton limestone*, or *Llandeilo flags* of England, by its numerous organic remains. The whole range of strata, through which one passes between Prairie du Chien and St. Paul, the end of steamboat navigation on the Mississippi, belongs therefore to the oldest fossiliferous formations.

From here heavy layers of diluvium (the *drift-formation* of North America) cover all the older rocks, and other outcrops are found only at 75 (English) miles higher up the river. Here, however, the rocks are crystalline, and appear in low ranges, which fall away gradually toward the land and disappear in swamps or sandy prairies. Here the Mississippi flows over an extent of 20 miles* through heavy crystalline rocks, with numerous windings and angles; further north is encountered a similarly wide zone of metamorphic schist—mica, talc and clay slates—and of gneiss-like rocks.

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* In this paper English miles are always meant.

This system of rocks corresponds to the Laurentian, and in the northern part, probably to the Huronian formation. It consists in great part of the most diversified granitic, syenitic, dioritic and gabbro-like rocks, while they seem to lack diabase entirely. Here belong the rocks from St. Cloud, Sauk Rapids, Watab and Little Falls, which below are fully described. It is remarkable that to the south from this zone of massive rocks there are no schists in outcrop, though it is probable that they are covered by the drift which constitutes the greater part of the surface of Minnesota and attains to a considerable thickness.

In the neighborhood of St. Cloud the Sauk river empties into the Mississippi. It has its rise in the lakes of northwestern Minnesota, and flows in its lower part, diagonally across the zone of Laurentian rocks a distance of 25 miles. These here constitute long, but low ranges of hills, generally covered by thick forests, but actually appear only in small areas in the river itself. Here the water flows rapidly, causing everywhere little water-falls and rapids. If one goes back from the shores of the river, the hills flatten out, and every trace of the older rocks disappears at once, under a heavy covering of debris and drift. From this region are derived the rocks from the west of St. Cloud, from Rockville, Cold Spring and Richmond.

Beyond the latter point the zone of the crystalline rocks cannot be traced, and at the same time here begins the area of the western prairies. The river cuts but few feet into the table-land, and affords no more outcrops of rock. From here one can travel all day in a westerly direction without seeing anything but deposits of drift, either of sand or clay, perfectly flat and without fossils, or somewhat greater accumulations of gravel and boulders, which latter are always to be seen in great quantities about the shores of the numerous lakes. So far as known to me, solid rock is exposed at but one point west of Richmond. In the thriving little town of Sauk Center, peopled mainly by Germans, I learned that stone-quarries had lately been opened in the neighborhood. The place lies 43 miles west from the Mississippi. At a distance of ½ mile south from the town can be seen a gentle elevation extending from northwest to southeast. On approaching this, one sees the soil and drift thrown out, and a little stone-quarry opened in two wholly different crystalline rocks—one a granite of a red color and somewhat gneissic texture, and the other a dark rock which in an earlier work* I distinguished as a diabase, but which now is known as a dioritic rock, and in our special investigation of these rocks, is proved to be a quartz-dioryte (No. 14).

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* J. H. Kloos: *A Cretaceous basin in the Sauk valley, Minnesota;* Dana and Silliman's Journal, 1872, p. 26.

As concerns now the outcrops of the separate rocks which are fully described in this work, the syenitic-granite (No. 20) is derived from St. Cloud and from Sauk Rapids (Nos. 18 and 19), and was designated as such in an earlier paper.§ They constitute sometimes rounded, somewhat elongated, gently rising hills, the intervals between them being filled with diluvial deposits, and sometimes low reefs in the river bed, or isolated knobs in the swampy lowlands along the river. The rapids in the Mississippi above St. Cloud, known as Sauk Rapids, are caused by syenite-granite. In the village so named may be seen in the syenite-granite three parallel small dykes of black melaphyr (No. 4) which also can be followed to the opposite shore; but here they are not in the syenite-granite, but penetrate a beautiful, exceedingly hard, syenitic granite-porphyry.

Six miles further north, at the small town of Watab (already half forgotten) several fine rocks outcrop. The hills here rise higher and are larger and the rocks rougher and wilder; unfortunately the region is heavily wooded, and only at isolated points could the rocks be freshly broken. From Watab were examined and described: augite-quartz-dioryte, (Nos. 16 and 17) syenite-granite (No. 22), and a melaphyr-like rock (No. 5). The white granite from Watab described in the *Geological Notes on Minnesota* (see above) is different from these, and outcrops only to a small extent. Furthermore the outcrops here are too limited to enable one to judge of the relations of the rocks to each other. One gets the impression, however, on the spot, that the coarse-grained granitic rocks penetrate through the fine-grained hornblendic rocks in the manner of dykes. Certainly that is the case at one spot where a fine-grained hornblendic rock, which besides two kinds of feldspar contains quartz and mica, is penetrated by very small granite dykes and veins.

At the village of Little Falls, which in part is inhabited by Indian half-breeds, the Mississippi reaches a slaty formation and forms, in passing over the outcropping beds, a series of rapids which produce a superior water-power, while the banks of the river here are high, and the channel is narrowed by a number of small islands through which opportunity is afforded for improvement by dams and locks. Inasmuch as the water generally has taken the direction of the strike of the rock-beds, it is difficult to determine the thickness of this slaty formation. It must however be very considerable. From a number of observations at various places I ascertained the strike of the bedding, N. 35° to N. 40°,* the dip toward the NW. 65° to 72°, while on the other hand the slatiness has a dip in the opposite direction at an angle of 70° to 80°. The nature of the beds is changeable, both in the direction of the strike and in the dip. Roofing-slates are widely disseminated; north from this place mica-schists prevail; toward the south the beds assume the character of a fine-grained gneiss, which is interbedded with layers of a beautiful angite-dioryte (Nos. 9, 10, 11, and 12). The first outcrops of this rock appear somewhat down the river, southwest from the village at the mouth of a little creek. They are twelve to fifteen feet high, and show the augite-dioryte variously developed. In the creek, farther up, rocks come to light which have a somewhat different character. They are described further on as augite-dioryte No. 13. In what relation these rocks stand to each other could not be determined.

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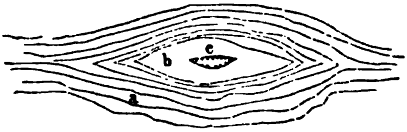
§ Geological notes on Minnesota. Zeit. d. d geol. Ges. 1871 p. 428: Tenth annual report of the geol. and nat. hist. sur. Minn. 1881, p. 175.

In the crystalline roofing-slates at Little Falls are small lenticular parts, a foot in size, of a crystalline rock which was analyzed, and below is designated a quartz-dioryte (No. 15).



a. Crystalline schists. *b.* Quartz-dioryte. *c.* Drusy quartz.

This woodcut shows the appearance of these septaria of quartz-dioryte in the slates. They reach quite frequently a length of several feet. The rock contains little garnets disseminated through it, which along the margins of the septaria are in greater abundance. When the septaria are large they have a cavity in the center, the sides of which are very often clothed with crystals of quartz. The slates bend completely round the septaria.

Whether the slate formation here described must be reckoned as a part of the Laurentian formation, or of the Huronian, must remain undecided. In any case it presents a totally different character from the syenitic knobs at St. Cloud and Watab, and the slates appear not to have any connection at all with them.

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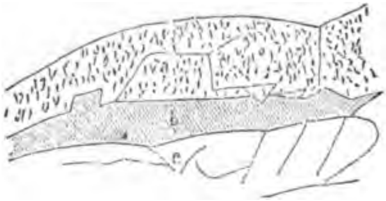
* Whether to the east or west of north the author does not state.—*N. H. W.*

Toward the north from Little Falls the firm rocks immediately disappear again under a heavy covering of sand and gravel. The banks of the river, which are in general heavily wooded, nowhere afford any outcrops of rock. The first rocky layers that are seen, are much further toward the north, at the well-known Pokegoma falls, and consist of banks of granular sandstone.

If one pursues the road from St. Cloud which leads up the fertile valley of the Sauk, (in which very many Germans are settled) he finds the first outcropping rock in the woods, three and a half miles west of the town, at a point where the road first reaches the river. It is a medium-grained syenite-granite, of a reddish color, with a structure somewhat porphyritic. Granitic rocks now remain a constant object in sight, sometimes in the bed of the river, and sometimes in the wooded bluffs along both shores. The finest outcrops are found by a little village named Cold Spring, fifteen miles from St. Cloud. Here the river has cut through a nearly parallel range of hills, the strike of which is about east and west. A finely granular porphyritic granite changes to a very coarse-grained syenite-granite. The latter in this region is very widely distributed, and extends even to Richmond.

The village of Richmond lies on a little sandy but well-tilled prairie, which on all sides is surrounded by high, wooded hills. Here appear Cretaceous beds in some thickness, and they have a character which unites them with those on the upper Missouri. The plastic clays of the Cretaceous rest immediately upon kaolinized granite. In the vicinity of Richmond is abundant opportunity to examine the coarse-grained granite in its relation with the augite-dioryte. For a mile southeast of the village are knobs of this rock in the immediate neighborhood of granite; and in the same region, a little farther away, is a stone quarry where, as the following woodcut shows, the dark, fine-grained augite-dioryte is overlain by a coarse-grained much weathered granite.

The bed *c*, which rises up so as to form a terrace, consists of a firm, hard-weathering rock, and dips toward the hill at an angle of about 45°, passing under the granite. It is exposed a thickness of about ten feet. The line of contact with the granite is covered with a lot of decayed debris from the granite. Under the bed *b* the granite cannot be found, inasmuch as the rock has been laid bare and followed only so far as it has proved useful for building stone; but it is very probable that the augite-dioryte exists in the granite in the form of a dyke. Similar appearances were fre-



a. Granite.
b. Debris from the easily weathered granular granite.
c. Augite-dioryte, forming an evident terrace-like bench.

quently encountered in the surrounding fields and farms; the augite-dioryte here is certainly so displayed that it must be styled a dyke cutting through the granular granite.

We pass now to the description of the field-appearances of those rocks which were procured from the neighborhood of lake Superior.

The St. Louis river rises in northeastern Minnesota, south of Vermilion lake, in a region of granite, gneiss and crystalline slates, which form a branch from the Laurentian formation as it is displayed in the region north of lake Superior. Shortly before the river empties into lake Superior it makes a sharp turn toward the east, and here passes through a picturesque, heavily-wooded region known under the name of "the dalles of the St. Louis river." The water has broken through the steeply tilted slates, and rushes over them in a long series of the most romantic falls and rapids; in the distance of a few miles the descent of the water amounts to 370 feet.

The beds consist of a series of roofing-slates and of a gray fine-grained rock which at first glance seems to be a dark quartzyte, or a fine-grained graywacke sandstone, the more exact nature of which it is however not possible to state. This formation, which occupies a great extent of country, forms, very probably, the representative of the Huronian as it has been described in northern Michigan, by H. Credner.* Further down the valley, toward lake Superior, the lower part of the Potsdam sandstone lies in unconformable position on the outcropping knobs of these old schists.

Going by the *Lake Superior & Mississippi railroad* to the foot of the plateau which locks in the mouth of the St. Louis river (which here spreads very widely) one beholds high cliffs of a coarse-grained rock. It is known under the name of *Duluth granite*, and as such it is far and widely distributed, and is worked into monuments. This rock has been designated in *Geological notes* on *Minnesota* a gabbro, or hypersthenyte, and has received, in the following descriptions, the name hornblende-gabbro (No. 6.)

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* Compare Zeit. d. d. geol. Gesel. 1871. p. 438; and Credner's article, 1869, p. 523

The distance from the highway, where the rock is very finely exposed, to the most westerly point of lake Superior, may amount to a mile and a half or two miles, on the side of the hill, and upon the alluvium of the river at the foot of it, has been established within a few years a new city which has acquired a considerable renown as the beginning point of the Northern Pacific railroad, under the name of Duluth. In the vicinity of Duluth which was originally covered with heavy forest, only imperfect observations could be made a few years ago, yet enough to convince one that here the crystalline rocks greatly prevail, and that the old sedimentary rocks are entirely wanting.

The leading variety of rock at Duluth, which is washed by the waves of the lake, has already been described as a porphyry.* This rock now, after a searching investigation, has received the name of melaphyr-porphyry (No. 1.) In some places it changes to a beautiful amygdaloid, but without showing at any place a sharp line of separation. Besides the hornblende-gabbro and the melaphyr-porphry, there is still a third rock at Duluth, which is separated from the melaphyr-porphry by a sharper boundary. It was seen only in a little quarry, and is certainly also a melaphyr (No. 3), although of a darker color, and similar to those small dykes which cut through the syenite-granite and granite-porphyry on the Mississippi at Sauk Rapids. At the point of contact with the melaphyr-porphyry it becomes firm and compact; at a distance from it it has a middling coarse, granular structure, and the lines of the striated feldspar can be seen without difficulty.

The rocks at the western end of lake Superior belong without doubt to the age of the Potsdam sandstone, and form a part of the solidified outflows of basic crystalline rock which took place at the end of the Huronian and at the beginning of the Silurian ages. They are to be compared to the dykes and overflows of basalt and doleryte which took place in later times, and which can be traced, in the western part of the American continent, over extensive areas.

On the St. Croix river, the boundary between the states of Minnesota and Wisconsin, at a distance of 100 miles from the last described locality, appears a similar melaphyr-porphyry (No. 2), which lies immediately below the sandstone and conglomerate of the age of the Lower Silurian. In conjunction with these it forms here a narrow valley, which on account of the romantic forms of its cliffs attracts there yearly many tourists. It bears the name: *Dalles of the St. Croix river.* The bedded rocks have, in great numbers, *Lingula antiqua* and *prisca*, as well as *Orbicula prima*, and the small bucklers of *Conocephalus*, and these fossils are altogether unchanged in the granular sandstone which lies immediately on the melaphyr-prophyry. The presence of an evidently bedded conglomerate consisting of great water-worn masses from the latter rock, which in the neighborhood of the town of Taylor's Falls underlies unconformably the sandstone, points to the Huronian age of this melaphyr-prophyry.* It differs from that of lake Superior only in color. This forms frequently an amygdaloid in which the cavities are filled, it is true, solely with quartz, while the amygdaloids of lake Superior exhibit, in connection with a more changed groundmass, also calcite, epidote and a crumbling mineral rich in iron and manganese, in the amygdaloidal cavities.

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* Z. d. d. g. G. 1871, p. 441, and the ninth report of the Minnesota geological survey.

We will now at the close of this brief account of the appearance in the field of these crystalline rocks, which we are about to describe further, bring together concisely, for the purpose of quick classification, observations made concerning their age, *viz:* The granite, syenite-granite, syenite-granite-porphyry and the augite-granite, as well as the quartz-dioryte and the augite-quartz-dioryte in the Mississippi region, probably all belong to the Laurentain formation; while the hornblende-gabbro and melaphyr-porphyry of lake Superior, and from the St. Croix river, are to be ranked in some later period, and probably to the end of the Huronian and beginning of the Silurian.

SPECIAL DESCRIPTION OF THE ROCKS.

By A. Streng.

These crystalline rocks from Minnesota can be divided, from a petrographic standpoint, into seven rock-species:

1. **Melaphyr.** These are basic, augitic rocks free from hornblende.

2. Basic rocks, which, besides hornblende, contain much evident diallage as well as a great deal of magnetic and titanic iron. These are distinguished as **Hornblende-gabbro.**

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* Compare *Zeit. d. d. g. G.* 1871, p. 433. Here this rock is likewise distinguished as porphyry.

3. Basic rocks which are like the foregoing in their mineralogical composition, and besides very much hornblende contain some diallage, which, however, for the most part, is intimately associated with the hornblende. These are distinguished as AUGITE-DIORYTE.

4. Quartzose dioryte, without augite—QUARTZ-DIORYTE—this is a siliceous more wide-spread species of rocks.

5. Quartzose diorytes with augite, are also wide-spread siliceous rocks, and are designated AUGITE-QUARTZ-DIORYTE.

6. Hornblendic granites are grouped under the name SYENITE-GRANITE.

7. GRANITE, *i. e.* without hornblende.

I. MELAPHYRS.

The melaphyrs appear in two varieties:

(*a.*) *Melaphyr-porphyry.*

(*b.*) *Compact or granular melaphyr.*

(*a*) *Melaphyr-porphyry* (epidote-melaphyr.)

This rock is found in outcrop in two places, viz: at Duluth on lake Superior, and on the St. Croix river on the boundary between Minnesota and Wisconsin.

1. *Melaphyr-porphyry from Duluth.*—The freshest of these rocks is on a hand-sample in which it appears along with a compact melaphyr and is sharply separated from it. Unfortunately there was present only so small a piece of this contact rock that an analysis of it could not be made. The other specimens which had been exposed to the disintegrating and changing effect of penetrating water, are not so fresh as this, and contain almost uniformly, epidote, while the before-mentioned contact-rock is free from it.

This rock consists, macroscopically, when in fresh condition, of a nearly black, or dark-green, groundmass, which is fine-grained and very compact, but which when less fresh is of a dark greenish-brown color, with numerous porphyritic bands, and contains the following minerals:

(1) A triclinic feldspar in elongated separate crystals, 5-15 mm. long, and from 0.5 to 3 mm. wide, flesh-red to colorless, brightly glistening, and strongly striated. Generally a crystal-grain consists of several rather wide bands, the first of which grows together with the second, and this again with the third, etc.

according to the rule: "The twinning axis the principal axis." The first, third and fifth bands have consequently the same position with respect to each other, as well as the second, fourth and sixth; but the first group stands to the second in the relation of the above mentioned twinning-law. The cleavage surface oP therefore reflects light in the bands 1, 3 and 5, all at the same time, while the bands 2, 4 and 6 do not reflect. But each separate band consists again of a great number of very fine lamellæ which stand to each other on the plane $\infty\breve{P}\infty$ according to the law—"the twinning axis a normal;" it is the usual polysynthetic twinning of the triclinic feldspars. The principal cleavage surfaces appear therefore striated, and the striation is parallel to the twinning lines which the broad bands make in conformity to the other law of increase.

Sometimes, though rarely, a striation of the plane oP cannot be seen; that this non-striated plane is actually oP, can easily be discovered, so long as the crystal concerned exhibits a Carlsbad twinning. But these few non-striated instances differ in no respect from the other triclinic feldspars, inasmuch as in them the striation is frequently too dim to be distinguished. Furthermore there appear isolated crystals of a sharply defined outline, regularly six-sided, which show no striation on their cleavage planes, and from their somewhat different luster appear to be a different feldspar, and probably consist of orthoclase.

(2) Far less frequent are angular, isolated, crystals, of diameters up to 7 mm., of a dark greenish-black color, which consists of a granular aggregate of a chlorite-like mineral. They are tolerably soft, and have a bright greenish-gray streak. Unfortunately in the freshest of the rock-samples nothing of this aggregate was to be seen. Sometimes little grains of iron pyrite are set in it. This chloritic mineral is here evidently the product of change from some earlier existing mineral.

(3) Associated with this dark-green mineral and often bound up within it, is also found at present a bright, greenish-yellow one, which consists of a group of small glittering individuals which must be considered epidote. Sometimes epidote-clusters, however, have become quite soft through change; and there are now parts of the rock so changed that they contain these bright greenish-yellow, softened masses, in great numbers. This epidote penetrates everywhere into the dark-green mineral, and it seems almost as if it were a product of change of the latter. In the freshest of the altered rocks it is not found.

(4) Frequently there are black grains that have a greasy or metallic luster and a conchoidal fracture. These might be either magnetic or titanic iron. In order to relieve this doubt, the finely powdered rock was subjected to a systematic washing-process, from which was obtained a black, metallic, perfectly magnetic residue. This was dissolved with acid potassium-sulphate, the solution was treated with cold water, and the filtered solution, containing sulphuric to saturation, was boiled. From this there arose scarcely a trace of turbidity, so that the mineral is not titanic iron, but magnetite, of which sometimes the octahedral form can be seen.

Sometimes this rock has the form of an amygdaloid, in which the irregularly shaped amygdules consist of more or less weathered, fine-grained clusters of epidote near the surface, and have a compact central portion of a larger feldspathic crystal, or are filled sometimes with quartz. Generally these amygdules are not so distinctly limited as those of most melaphyrs. Other roundish inclosures consist of an aggregate of two minerals—one clear, and the other entirely black but affording a reddish-brown streak; both are so weathered that they cannot be determined.

The microscopic examination gave the following :

(1.) The feldspars appear sometimes mixed through the groundmass, and sometimes in larger enclosed grains. Between crossed Nicols they are very plainly and sharply striated. But seldom are any wholly non-striated feldspars to be seen. Their color is light-brown, although the crystals are for the most part filled with substances of other colors, namely :

(*a*) Clear-brown or gray, exceedingly fine grains which permeate the feldspar, and color it brown. Only exceptionally is the feldspar free from them; and it appears then colorless ; especially is this the case in the farthest parts.

(*b*) Clear, bluish-green scales, grains and needles of the augitic portion of the groundmass.

(*c*) Bright yellow or grayish-green epidote in irregular, angular aggregations or crystals, but which are wanting in the freshest portion of the rock.

(*d*) Here and there lie black clusters of irregular grains of magnetic iron.

(*e*) Little fluid-inclusions sometimes appear, containing movable bubbles.

(2) Only in the freshest portions of the groundmass are to be seen crystals of pure unchanged augite. It is colorless to light-brown, but colored a light-green in the few fresh rocks. It is

either entirely homogeneous, or slightly fibrous, shows often regular outlines, which correspond to the forms of augite, inasmuch as the angle $\infty P : \infty P \infty$ of augite was found to be about 135°, and the angle $\infty P : \infty$ about 90°. The colorless and light-brown grains show in polarized light bright colors, but they are almost non-dichroitic. In these pure augites are found irregular fractures, also rounded, rather large opaque grains, as well as very fine, often numerously aggregated, round or elongated cavities with immovable bubbles. Even in the freshest rock can be seen numerous augites that are more or less filled with irregular grains of viridite.[*] Still more markedly is this the case in those portions in which the augite appears light-green and somewhat fibrous, without being dichroitic. These augites are changed; since it can be seen plainly in what way the green grains, or fibrous substance, more and more enters into them. In consequence of which the augites in many parts are replaced by a mass of viridite which is altogether homogeneous in appearance, and between the Nicols appears only light and dark, and exhibits no color at all.

Occasionally there are also larger crystals of this mineral. In reflected light they are dark, in transmitted light they are light bluish-green, but between crossed Nicols either granular or confusedly fibrous without marked color-characters. They are but slightly dichroitic or entirely non-dichroitic. Since these larger crystals correspond to the augite that is impregnated with viridite one would be warranted in regarding those grains which appear macroscopically as aggregates of fine chlorite-scales, as changed augite. These larger grains of the much-changed augite are everywhere intimately connected with quartz and epidote.

(3) In nearly all portions except the freshest, epidote is found, sometimes in large aggregates, sometimes as a portion of the groundmass or lodged in the feldspar. In the former case it is united, as already mentioned, with accumulations of viridite, and with grains of quartz. The epidote is light greenish-yellow in reflected light, in transmitted light faintly yellow, sometimes nearly colorless; it exhibits in polarized light very brilliant colors, but is not strongly dichroitic, which may stand in close connection with its bright coloration. It is not, besides, very pure, inasmuch as it is filled generally with gray granules. The larger individuals show small fissures which are parallel with the long axis, and correspond with the principal cleavage plane. In some places the epi-

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[*] The name viridite is used to designate a chloritic or delessite-like mineral the nature of which is not accurately determined.

dote was in columnar, plainly outlined, separate little crystals, with their terminal planes set obliquely, answering to hemi-pyramids.

(4) Quartz is found only very scatteringly in small, or sometimes larger, grains which fill the interstices between the other minerals. It is associated especially with the viriditic and epidotic grains. It is sometimes wholly clear, and nearly free from inclusions, but sometimes contains scales of augite or grains of magnetite, or spicules of apatite. Sometimes there are fluid inclusions, occasionally with bubbles that are visibly in motion. In one such cavity were seen two black grains, besides the movable bubble, which were continually thrown hither and thither upon the bubble. In the freshest part of the rock were impure grains of quartz which contained numerous needles of apatite, as well as green grains in great quantity which like amygdules were surrounded by a coating consisting of grayish-green viridite.

(5) Rarely there are rather large clusters, more frequently distinct crystals, of magnetite with sides of four or six angles.

(6) A mineral of irregular outlines, which is white or yellowish in reflected light and but slightly translucent, and filled with granular substance, is certainly a product of change from epidote or feldspar.

(7) Slender, but generally very long, nearly colorless spicules, which have pyramidal terminations, or basic pinacoids, and also very shapely six-sided sections, are apatite. They often penetrate several minerals. But sometimes these crystals are so short and thick, that it was doubtful whether they should be regarded as apatite, or might be regarded, perhaps, as nepheline, as they are soluble in acids. By treating several of the thicker crystals in nitric acid solution, with molybdate of ammonia, and others with nitric and sulphuric acids, the determination could be reached, under the microscope, that they were certainly apatite. Moreover, the sections of this apatite sometimes consist of equal-sided triangles, the angles of which are occasionally rounded, and sometimes are not. The hexagonal crystal here appears, therefore, to take a hemihedral form.

The apatite here is not everywhere entirely pure, but sometimes contains individual cavities, or a fine needle-shaped small crystal, which lies in the middle of the larger crystal, parallel to the longer axis. Very frequently are the needle-shaped apatites seen to be fissured, and even broken, and the parts a little displaced from each other.

(8) Very rarely yellow metallic grains of pyrite make their appearance.

The chemical analysis of the melaphyr-porphyry No. 1, from Duluth, gave the following result :—

Silica,	50.03
Alumina,	15.38
Sesquioxide of iron,	11.78
Protoxide of iron	3.90
Calcium oxide.	5.39
Magnesium oxide,	3.60
Potassium oxide,	1.14
Sodium oxide,	5.01
Water.	2.73
Carbonic acid,	0.98
	99.94
Phosphoric acid,	0.33

From this analysis it appears that the rock is comparatively very basic, at least as compared with the porphyries, in which the proportion of silica generally exceeds 60 per cent. At the same time it contains so little potash that the amount of orthoclase can be only very slight—at the highest, 6.74 per cent.—while in the porphyries it is present in far greater amount. In connection with this small amount of orthoclase, also appears the low per cent. of silica. As a part of the lime is required by the augite and epidote, only a portion of it is left for the triclinic feldspar: the sodium would, therefore, exceed the lime in this mineral. But since this feldspar is filled completely with a granular substance, which can be regarded only as a product of its own decomposition ; since, moreover, the content of carbonic acid in the rock gives evidence that the lime is no longer in its original condition, and a part of it can, therefore, be removed entirely from the stone ; and since, also, finally, the high percentage of water points to a high degree of decay and weathering, by means of which, first of all, the lime would be carried away, therefore it is necessary to conclude that the feldspar has also lost a portion of its lime. This also follows from the low per cent. of silica in the rock, since if the plagioclase contained considerably more soda than lime, it would also possess a content of silica which would exceed 60 per cent. But still the rock is too basic. Therefore it is permissible to conclude that the originally highly-calcareous plagioclase stood very near labradorite, perhaps, also andesine. The similarly high content of iron, which in part is due to the not insignificant amount of magnetite, must be mainly set down to the credit of the augitic ingredients in proportion as they are altered, since the amount of magnesia is remarkably low, and the lime may be embraced principally in the epidote and the plagioclase. There remain, therefore, for the unchanged augitic mineral, besides magnesia and some lime, especially the oxides of iron, so far as they are not used in the formation of magnetite. The per cent. of apatite amounts to 81.

As it has been said already that the epidote seems to be a product of change from the green chlorite mineral, so it is necessary to hold it as highly probable, according to the microscopic examination, that the original augitic mineral decayed in various ways, sometimes forming basic epidote with the separation of free silica, and sometimes the chloritic mineral. These were deposited in the place of the augite, or in other places. These three minerals therefore are to be regarded as secondary products.

2 *Melaphyr-porphyry from Taylor's Falls*, or St. Croix Falls, on the St. Croix river, a tributary of the Mississippi. Macroscopically this rock appears porphyritic throughout, sometimes also amygdaloidal. Occasionally, however, all porphyritic structure is wanting, as, for instance, on the right shore of the St. Croix river, although decidedly porphyritic rocks exist very near. These consist of a greenish-gray to brownish, finely granular and crystalline groundmass, with numerous porphyritic crystals of brown plagioclase. In immediate proximity are found abundantly quartzose secretions that are frequently furnished with dark-green coatings, so that this is certainly to be regarded as an amygdaloid. Further there appear distinct secretions of a greenish black, chlorite-like mineral. Sprinkled in the groundmass can be seen also, with the naked eye, numerous fine grains of a bright yellowish-green mineral, which, as appears under the microscope, consists of epidote. Sometimes this epidote is liberally disseminated in those portions which are not porphyritic, so that by means of it the whole rock is rendered green. Even macroscopically it can here be seen that the plagioclase becomes changed to the dark-green chlorite-like mineral, inasmuch as it takes itself a green color even when the cleavage planes still retain their luster. Here also appear distinct sparkles of pyrite.

The microscopic examination led to the following determinations:

(1) Plagioclase, generally brown, colored by means of brown and gray particles. Besides these it contains small grains and scales of the augitic substance changed to viridite or chlorite,

which sometimes so much prevails that it nearly fills the whole plagioclase crystal, leaving only a little feldspathic residue. Further, crystals of epidote are also formed abundantly in the feldspar. The plagioclase constitutes a part of the groundmass sometimes, and sometimes it is disseminated prophyritically.

(2) The augite parts are wholly changed to viridite. The larger crystals of this mineral, which are connected closely with epidote and quartz, more rarely appear; while the smaller ones are very abundant, such as usually only fill the interstices between the laminæ of the feldspar, even constituting sometimes a part of the groundmass. In polarized light the mineral appears granular and either radiately or confusedly fibrous.

(3) One of the most common parts is epidote, which rarely occurs in large grains, but generally in rather small crystals of a bright yellow color. These are of imperfect shapes, but sometimes of regular forms. They are feebly dichroic, but show very brilliant polarization colors. Generally they are tolerably pure; sometimes they contain inclusions of quartz. Very often they are penetrated by irregular brown cracks. Rarely is the epidote filled with viridite; in nearly all cases it resists the spreading of the viriditic substance even when the feldspar itself is filled completely with it.

(4) Quartz secretions, large and small, appear in polarized light as aggregates which are enveloped in a granular green substance, and for that reason they must be considered as of amygdaloidal character.

(5) Also a white granular substance is here visible.

(6) Magnetite, and

(7) Apatite in slender needles also appear.

From the foregoing it follows that the melaphyr-porphyries from Duluth and Taylor's Falls have an undoubted porphyritic structure. The porphyritic portions consist of plagioclase, in connection with which very little orthoclase occurs; of an aggregate of chlorite-like grains (viridite) which are believed to be a product of change from augite; of an aggregate of epidote; of small amygdaloidal quartz masses, but which do not occur everywhere; and of small sparkling grains of pyrite. Aggregates of two much weathered minerals could not be determined exactly; they certainly form concretions in the two principal parts. The groundmass consists principally of plagioclase (probably also some orthoclase); augite, which, however, is principally changed to viridite; magnetite; apatite; epidote, often gresent in large quantity; a little quartz, and a grayish-white *granular substance that has resulted from change.* When the rock is amygdaloidal, quartz fills the cavities, as well as calcite and epidote.

According to this the rock is such that it is embraced with the melaphyrs ; and as it has a decidedly porphyritic structure, it may be designated *melaphyr-porphyry.* Now, in most parts, except in the freshest, epidote plays a very important role ; it can therefore also be designated an *epidote-melaphyr.* But because the epidote is a secondary product, as well as the viridite, which has come from a change in the augite, this latter name can be applied only to the changed melaphyr-porphyry.

(*b*) *Compact and granular melaphyr.*

This rock exists at several places.

3. Of *melaphyr from Duluth* there were only a few small pieces. It is found in close contact with the fresh melaphyr-porphyry. The definition of it is very distinct. Unfortunately the pieces for examination were too small to make an analysis of them, and the microscopic examination had also to be made on a series of fragments in order to characterize the rock definitely.

One of the two pieces, *a*, is derived from the border close by the melaphyr-porphyry ; the other, *b*, is from a point further removed from it.

The contact-rock, *a*, exhibits itself as a dense, dark grayish-black rock in which under the loop can be distinguished only very fine needles.

Under the microscope can be seen, in a very fine-grained groundmass fine, slender, colorless crystalline, needle-shaped feldspar crystals, which show very seldom any twinning striation, and give no bright colors when tested in polarized light. They are not very sharply separated from the groundmass; while in the colorless, felsitic ground-paste, they blend without showing any boundaries, but in which there are enclosed numberless light-green, colorless very fine grains of an augitic mineral, as well as some large, four-angled crystals of magnetite. The colorless ground-paste hardly shows any change in polarized light; between crossed Nicols it remains dark when the stage is revolved.

The other rock, *b*, derived from the midst of the melaphyr, consists of a middling to a fine-grained mixture of tolerably bright triclinic feldspar, and an augitic mineral which is mostly lusterless and colored black, or sometimes shining with a yellowish metallic luster, and under the microscope is translucent and brownish green, and which is penetrated by numerous partly parallel or sometimes irregularly disposed, dark fissures, and is filled with pores of very irregular shapes. Occasionally grains of magnetite and spicules of apatite appear. The feldspars are often partly filled with brownish green clouds derived from the augites. Notwithstanding the brightness of the feldspar, this rock is very much changed, so that it is very soft and crumbling.

Accordingly this melaphyr in general is middling to fine-grained, but on the margins of contact it is very fine-grained. Hence one may draw the conclusion that at Duluth the melaphyr cuts through the melaphyr-porphyry, inasmuch as the latter is unchanged on its margin alongside of the melaphyr, but the former is rendered dense along this contact.

4 *Melaphyr from Sauk Rapids on the Mississippi.* This rock consists of a fine-grained, anamesite-like greenish-black groundmass of very fresh appearance, in which are enclosed narrow slender crystals, more rarely large ones, of very bright triclinic feldspar. The number of the larger crystals is so small that the rock at first sight hardly has the appearance of a porphyry.

Under the microscope the contrast between the crystalline groundmass and the larger crystals is very evident. Nevertheless it is observed at once that the crystals are of two kinds—triclinic feldspar and augite. The ingredients of the rock are, under the microscope, the following:

(1) Triclinic feldspar, with clear and nearly everywhere visible, sharp twinning lines, appears sometimes in large, sharply defined crystals, and sometimes in small bands as a portion of the groundmass. This mineral is very clear and pure, and contains only rarely in its interior a large accumulation of gray grains; sometimes are seen in it also fine needles of augite and little crystals of magnetite.

(2). Large, more or less regular crystals, are seen but seldom in perfect form, which are surrounded by a bright green hardly dichroitic border. The inside consists of a very clear-brown or brownish-violet substance which is not dichroitic or soluble in acids, and shows but very rarely brilliant polarization colors. The purest portions are penetrated by irregular fissures, (though sometimes these stand at right angles to each other,) which are filled with a black substance. The most frequent occurrence of this mineral shows it filled almost wholly with black crystals of magnetite, which often are placed in two fine linear systems perpendicular to each other. Occasionally also pyrite appears in it. Other portions are filled completely with green, confusedly-fibrous masses which are more strongly dichroitic than the unchanged mineral. This latter consists of augite which is converted through fibrous viridite into the green substance. The green border on the unchanged augite is also such a product of change.

As a part of the groundmass, augite is crowded into the angles between the feldspars. It is bright brownish-green to completely colorless, but is here also converted into a light-green, finely fibrous, mineral, so that an augite-crystal sometimes appears wholly converted to a fibrous mass; and the separate bundles of fibres are projected into the surrounding feldspar. A change here also takes place to fibrous viridite. In other places the augite is colored more brown, and then becomes either fibrous or granular, the latter by reason of the occurrence of fine dark points. Sometimes such changed augites are more strongly dichroitic, but not so that they could be shown to change to hornblende. In this augite are included now, occasionally, well-formed apparently cubic or rhombic crystals of a bright, grayish-violet color, which, unfortunately, it was not possible to determine exactly.

(3) Four-sided magnetic grains, sometimes separate, and sometimes grouped. From the pulverized rock it is possible to bring out with a magnet numerous grains of this mineral.

(4) Fine needles of apatite are seen clustered in several places.

(5) Very rarely are there scattered aggregates of quartz.

The chemical analysis of melaphyr No. 4 gave the following result:

SiO_2	48.97	
Al_2O_3	16.50	
Fe_2O_3	4.14	
FeO	6.58	
CaO	10.93	
MgO	9.85	
K_2O	0.69	
Na_2O	2.69	(with traces of Li_2O)
H_2O	1.14	
	101.49	
P_2O_5	1.18	

From this analysis it appears that the rock is basic, more basic than many other melaphyrs. It agrees in the composition nearly with Bunsen's normal pyroxenic rocks; it differs from them especially in a too small content of alumina, iron oxide and protoxide, and in a too high content of magnesia. The small ingredient of potash shows that if orthoclase is at all present in the rock, it plays a very inferior part, the highest per cent. of it possible, being only 4.08. But, furthermore, the small content of soda, as well as the high per cent. of lime indicates that the plagioclase will approach nearer to anorthite than albite. Inasmuch as abundant magnetite is found in the rock there can be left, of the small content of iron oxide seen in the general analysis, but little iron for the augitic portion. This, therefore, must be the richer in magnesia and lime, which are present in large quantities. In the presence of the fresh appearance of the fieldspar everywhere, it will be necessary to charge the high per cent. of water to the account of the green secondary product of the augites. The conteut of phosphoric acid answers to a per cent. of apatite of 0.44.

From the foregoing it appears that the melaphyr from Sauk Rapids consists of a groundmass which holds a basic plagioclase; augite in changed and in unchanged conditions; also, in smaller grains, magnetite and apatite; and very seldom a little quartz; and that in this groundmass larger crystals of triclinic fieldspar and augite are sparsely disseminated. Hence this rock can also be designated a melaphyr-porphyry ; since, however, the prophyritic structure is not everywhere apparent, the rock may be designated simply a melaphyr.

This rock differs from the melaphyr-porphyry, of Duluth and Taylor's Falls, mineralogically only in the smaller amount of porphyritic structure, the lack of orthoclase and epidote, the very little amount of quartz and the greater purity of the general mass, and especially of the plagioclase; chemically it differs in the smaller per cent. of alkali, water and carbonic acid, and the evidently high per cent. of lime and magnesia.

5 *Malaphyr from Watab on the Mississippi.* This rock forms a fine-grained mixture of a colorless feldspar, a bright yellowish-green augitic mineral, and of isolated, small black grains. As a secondary product pyrite is disseminated in considerable amount. The whole rock is of a greenish-gray color, and has a fracture that is irregular and even splintery.

Under the microscope the feldspar can be distinguished as triclinic, the augite is of a bright greenish-brown color, which often becomes green by viridite; it is not dichroitic, is cut by irregular fine fissures, and embraces often an abundance of small black grains. Large, four-cornered, black grains of magnetite are seen only very rarely. Also needles of apatite are sprinkled here and there.

Melaphyr No. 5, therefore, consists also of plagioclase, augite, and a little magnetite and apatite.

II. HORNBLENDE-GABBRO.

This rock is found only on the *St. Louis river near Duluth.* It has at first glance the appearance of a granular hypersthenyte. Upon exact examination it proves to be a granular assemblage of the following minerals :

(1) Strongly predominating is a brilliantly glittering gray *plagioclase* with very evident twinning lines and blue iridescence exactly like that from Labrador. Sometimes also the polysynthetic twinning is formed according to the Carlsbad law.

(2) Occasionally are seen crystals of bright red feldspar without twinning lines, with a reddish reflection similar to sunstone. This mineral is certainly *orthoclase.*

(3) A dark brownish-green, or tombac-brown, slightly lustrous, almost metallic-looking mineral, which appears fibrous and possesses two similar cleavage directions, which form with each other an obtuse angle. A great number of casual measurements gave for this angle about 125°. Since this mineral, moreover, is rather easily fusible to a black glass, it can only be *hornblende,* notwithstanding its somewhat different appearance from ordinary hornblende. This is in many places manifestly impregnated with small scales of chlorite, and it attains by that means a somewhat different nature.

(4) Light tombac-brown, metallic-lustered crystals are somewhat more seldom to be distinguished easily, with only one strongly marked cleavage direction. A second very inconspicuous cleavage plane, with faint lusterless surfaces, stands nearly at right angles with the first. Before the blowpipe this mineral fuses with tolerable ease to a dark shining glass. It is therefore, without doubt, *diallage.* It is somewhat more rare than the hornblende, but it appears to stand in no relation with it.

(5) Large black, slightly metallic grains, sometimes with perfect octahedral forms, with irregular to conchoidal fracture. The fragments drawn from the powdered rock with a magnet were dissolved in acid potassium sulphate ; the aqueous solution was boiled with addition of sulphuric acid, by which a rather heavy

white precipitate of *titanic acid* ensued. Since the distinct octahedrons give no titanium reaction, but the magnetic powder is only partly dissolved in muriatic acid—the rest being titanic acid—therefore, titanic iron certainly is connected so intimately with magnetite that it follows with it to the magnet.

(6) Very rarely is seen a light, greenish-yellow mass with conchoidal fracture, and greasy luster, which is insoluble in muriatic acid, and before the blowpipe is almost infusible. The hardness is about 5 to 6. This mineral appears to be *epidote*, whose cleavage planes could not always be recognised.

(7) Very seldom occurs a sparkling grain of *copper pyrite.*

The microscope revealed the following minerals:

(1) Very prevalent triclinic feldspar, generally tolerably pure; but sometimes wholly filled with granular masses, so that the striation in it is very difficult to observe. Also black angular grains, probably of magnetite, are disseminated here and there. The mineral is insoluble in hydrochloric acid, after standing twenty-four hours; also its powder gave after long treatment with hydrochloric acid, no trace of jelly. The triclinic feldspar, therefore, is not anorthite, but evidently comes nearer to labradorite.

(2) In several places appear feldspars which are completely filled with yellowish or reddish grains, sometimes hornblende granules changed to green viridite, but more rarely bright yellow epidote. This mineral corresponds to the red sunstone-like feldspars, in which a twinning-striation can be seen neither macro- nor microscopically. This might now be obscured possibly wholly by reason of the numerous inclosures; but when it is observed that the rock contains 1.61 per cent. of potash, it is necessary to consider it very probable that some orthoclase is present.

(3) Hornblende. This is mostly of a light to dark green color, more rarely of a brownish-green. The former is produced by viriditic substance, which often completely fills the hornblende and impairs its dichroitic character. This green viriditic hornblende is formed sometimes of parallel fibers, but sometimes of confused or radiate fibers, as appears especially between crossed Nicols. The brownish-green hornblende, without viridite, is strongly dichroitic, and appears parallel-fibrous. Sometimes it is penetrated by regular, dark, parallel, fine lines, which run at right angles with the fibrous structure, and have nothing in common with the cleavage, which, singularly, is wholly absent. Since, moreover, the margins of the hornblendes are very irregular, and always are dependent upon the feldspars between which they are embraced, it might be

doubtful, in consequence of their often weakly dichroitic character, whether they be hornblendes or not. But the above-mentioned numerous measurements of the two similar cleavage planes show, with complete certainty, that the mineral consists of hornblende, which, by the intrusion of viriditic or chloritic substance, has acquired somewhat different characteristics.

(4) Diallage appears in grayish-brown sightly translucent crystals, which sometimes are isolated between the feldspars, and sometimes are connected with the hornblendes like a mosaic, where, however, its outlines are everywhere sharp. As the grains of diallage do not encroach at all upon the hornblende, the latter must be, it seems, an original mineral ingredient, and not at all a product of change from diallage. The diallage is almost entirely non-dichroitc; it is generally delicately fibrous in parallel threads, and shows abundantly a system of parallel, sharply defined fissures, which run, however, through the fibrous structure nearly at right angles. Parallel to the fibers, which between crossed Nicols show an irregular striping of colors, is sometimes a fine black hatching to be noticed, which seems to consist of grains of magnetite arranged in lines. Only rarely does the diallage exhibit a non-fibrous center, which then is free from the dark lines which fill the remaining portion of the crystal.

(5) Large, black, metallic, angular crystals of magnetite and menaccanite. Smaller grains are embraced in the above-mentioned minerals.

(6) Irregular patches and grains of epidote of a light yellow color, slightly dichroitic, appear very rarely.

(7) Chalcopyrite is very seldom visible.

(8) Rather frequent colorless prisms, sometimes 0.4 mm. in width and over 0.8 mm. in length, can be seen in thin sections. These are occasionally six-sided. They show very brilliant polarization-colors, and contain numerous fluid inclusions, with and without moving bubbles. They are soluble in acids, give with the molybdate solution a phosphoric acid reaction, with sulphuric acid a lime-reaction, while with the treatment in hydrochloric acid no cubes of chloride of sodium appear. The mineral is therefore apatite, in thick short crystals, while fine needles of it seldom appear.

(9) The most rare are colorless grains with numerous large fluid inclusions, which generally contain slightly movable bubbles, and are broken by irregular fissures that are filled with a green

substance. They stand in close connection with bits of epidote, and are, in spite of these impurities, to be considered as quartz.

The chemical composition of the hornblende-gabbro No. 6, is as follows:

Silica	49.15
Alumina	21.90
Sesquioxide of iron	6.60
Protoxide of iron	4.54
Lime	8.22
Magnesia	3.03
Potash	1.61
Soda	3.83
Water	1.92
	100.80
Phosphoric acid	0.33
Titanic acid	0.18

It is, therefore, a basic rock, whose high per cent. of alumina corresponds closely with its abundance of triclinic feldspar. If this feldspar were anorthite, the content of lime would have to be higher, and that of soda necessarily less. Furthermore, if this feldspar were oligoclase or andesite, the per cent. of silica of the whole rock would be higher, since the 1.61 per cent. of potash presupposes a content of orthoclase of about 9.52, which drives the silica to a high percentage. Therefore, the triclinic feldspar comes nearest to labradorite. While the silica per cent rises by reason of the orthoclase, it is reduced again by reason of the percentage of magnetite and menaccanite. The meager percentage of magnesia corresponds to the low content of hornblende and diallage in the rock. The apatite amounts to 0.81 per cent.

Therefore, the hornblende-gabbro from the St. Louis river near Duluth consists of strongly predominating plagioclase (labradorite), a little orthoclase, some hornblende, diallage, magnetite and menaccanite, as well as apatite, and a very small amount of chalcopyrite, and epidote, the last occasionally associated with quartz.

III. AUGITE-DIORYTE.

This rock occurs at Richmond on the Sauk river, and at Little Falls, above Watab on the Mississippi.

7. *Augite-Dioryte from Richmond.* This rock consists macroscopically of a coarse-grained mixture, apparently of predominating black hornblende and a grayish-white triclinic feldspar, besides an augitic mineral. In addition to these there are also biotite, pyrite and perhaps zircon.

The hornblende is sometimes in distinct large crystals from 2 to 3 centimeters wide, and from 3 to 4 centimeters long; while the most of it appears in crystals of only a few millemeters in diameter. It is of a deep, black color, has a bright lüster, and appears in general very fresh. Very frequent small scales of dark brown or black biotite, of irregular shapes, nestle within the cleavages of the hornblende. The latter fuses rather easily to a black shining glass.

The triclinic feldspar is clear, grayish-white, nearly colorless, in brightly lustrous crystals, with regularly angled cross-sections, and evident twinning striations. When the back-ground is dark, the feldspars often appear transparent as well as black.

The augitic mineral is only very slightly apparent, being mostly covered by hornblende. It is light, yellowish-brown or grayish brown in color, and slightly lustrous; but it becomes much brighter when the rock is wet, since it then acquires a yellowish, metallic lustre. Two cleavage planes can be seen cutting each other, nearly at right angles, but which are not very distinct, and appear not to be exactly similar. The mineral is somewhat fibrous, and fuses not very easily, in fine splinters, to a gray bead. It exists in less amount than either of the other constituents, and is itself to be seen under the lens with great difficulty.

Biotite, in thin brown or nearly black scales, is mingled especially with the hornblende.

Magnetite is recognizable, but without certainty; pyrite sometimes is disseminated in small grains.

Very rarely can be seen small crystals of a hyacinth-red color, which are brightly shining, but whose form cannot be ascertained. Perhaps they are little zircons.

The microscopic examination gave the following:

(1) The plagioclase shows very distinct color bands; it is generally very clear and pure. Here and there appear little needles of apatite in it: also shreds of hornblende and grains of magnetite; also gray kernels of irregular shapes are seen sometimes in groups. But very rarely does the feldspar appear without striping.

(2) The hornblende is of green and brown colors, strongly dichroitic with parallel cleavage, or with two cleavage systems that cross each other at a small angle. Its outlines are irregular. It sometimes embraces little grains, but in no great quantity; and very rarely cavities with movable bubbles.

(3) The augitic mineral is chiefly in immediate but irregular contact with hornblende. It can be traced out sharply in distinc-

tion from it, but its outline is irregular. Sometimes also specimens of this mineral lie in the feldspar, and also often little crystals of hornblende are in the center of the augite in such a manner that they intersect each other like a patience-play (Geduldspiel). It is only rarely that the augitic mineral is somewhat regularly outlined, but not so that the measurements of angles could be taken. It could only be discovered that the angle between two sides of such a section was more obtuse than the columnar angle of hornblende. The mineral is cut by irregular fissures which are only occasionally nearly parallel, but generally they go in all directions, cutting each other at all possible angles. It is generally very finely parallel-fibrous—that is to say it consists of a series of lamellæ parallel to each other, but which often wedge out in both directions, so that the fibers sometimes are in right lines, and sometimes appear slightly undulatory. The cracks which cut the mineral appear generally to have no reference to the direction of the fibers. Here and there is an appearance as if the cracks ran preferably at right angles to the fibrous structure. This augite is of a very bright brownish-red color. Between crossed Nicols it shows bright polarization colors, particularly in those spots where it is not remarkably fibrous. In the fibrous portions also there is a fine color-striping apparent, though this does not always appear distinct. It is therefore probable that a polysynthetic twinning structure is the fundamental cause of the fibrous structure.

This mineral is remarkably and strongly dichroitic in bright green and red colors. Beginning at the fissures which penetrate it, and along the margins, it undergoes a change which gradually embraces the whole mineral, so that the different stages of this change can be seen in the different thin-sections. The fissures are filled, for instance, with a bright grayish-green, non-dichroic substance which encroaches more and more on both sides, so that only the central parts, or kernels of the mineral, of more or less size, are visible, in its unchanged red color; and in many instances they are entirely faded out. At the same time the fibrous portions undergo no change, although they frequently appear more distinct. In many instances the augitic mineral consists only of bright green fibrous crystals. When the mineral is so changed it is not dichoric; so that it can with all certainty be seen to be augite. But the original red mineral can be only augite. The absence of a clearly defined cleavage-system, as it appears in connection with the adjoining hornblende, the very distinct optical characters in common and polarized light, the fibrous structure, the difficult fusibility, the presence of two cleavage surfaces nearly at right angles, visible even with the naked eye, distinguish this mineral from hornblende, and show it to be augite. Microscopically it appears very much like diallage, in which professor Zirkel, who had the goodness to make an examination of it at Jena, agrees with me. Besides, individual crystals appear which are pierced by parallel hornblende-lamellæ, in such a manner that augite and fibrous hornblende alternate with each other.

(4) Biotite appears in bright, grayish-brown, transparent, angular sheets.

(5) Quartz is very distinct in small grains in which sometimes are fluid inclusions with rapidly moving bubbles.

(6) In places numerous crystals of apatite appear, especially in the feldspar, but those places are rare. Sometimes the apatite is in isolated crystals.

(7) Magnetite is for the most part only scattered and rare. Only occasionally is it in somewhat thicker and crowded large irregular masses. The larger portion of a slide is free from it. For that reason it was, that no metallic residue could be obtained from the wet powdered rock. With a magnet only could individual grains be drawn out.

The chemical analysis of the augite-dioryte No. 7, gave the following result:

Silica	48.87
Alumina	18.72
Sesquioxide of iron	3.28
Protoxide of iron	5.55
Calcium-oxide	11.93
Magnesium oxide	9.53
Potassium oxide	0.73
Sodium oxide	2.10
Water	0.93
Carbonic acid	trace.
	101.64
Phosphoric acid	0.08

This rock therefore is also basic, and agrees with the normal pyroxenic rocks of Bunsen. Yet some free quartz is present. The high per cent. of lime and magnesia agrees with the abundance of plagioclase, hornblende and diallage; likewise the low per cent. of iron oxides with the meagerness of the magnetite, the low per cent. of potash with the absence of orthoclase, of which at the most 4.21 per cent of the rock could consist. The small per cent. of soda and the large per cent. of lime, considered in respect to the large amount of plagioclase present, warrant the conclusion that the latter comes nearer anorthite than albite, that it therefore is either labradorite or andesine. The small amount of water, which in a great measure consists of hygroscopic water, shows also that the rock is not entirely fresh. The apatite amounts only to 0.19 per cent.

The augite-dioryte No. 7 from Richmond therefore consists of a coarse to middling coarse-grained mixture of plagioclase, hornblende and diallage, with which is mingled biotite, a little pyrite and magnetite, a very little quartz, apatite, and very rarely perhaps zircon.

8. *Augite-dioryte from Richmond.* (Bareman's farm.) Although most intimately related to the foregoing in its outward appearance, this rock nevertheless shows a difference.

Macroscopically it appears as a fine to middling coarse-grained mass of very brilliantly shining, colorless, plagioclase, which sometimes also exhibits the Carlsbad twinning; also of black, very brightly lustrous hornblende, within which also very rarely isolated scales of biotite are visible; and of an augitic mineral, gray to browish-green in color, which appears in little grains. This last mineral is recognized plainly in places where the plagioclase forms white granular aggregates, in the neighborhood of which these greenish-brown grains are plainly secreted. They possess, so far as can be seen, not the cleavage planes of hornblende. Small black specks are magnetite, since such can be drawn out of the powdered rock with a magnet.

Isolated masses are seen that reach three centimeters in length and two in width, which consist of an aggregate of light-gray feldspars which sometimes are plainly striated, sometimes show no striation, but yet in other respects can not be distinguished one from the other.

From the foregoing therefore this rock differs in its lack of large hornblende crystals, in the presence of large aggregates of feldspar, and in its greater richness in magnetite.

Under the microscope can be recognized the following mineral ingredients:

(1) Very clear, wholly colorless, strongly striated plagioclase, which contains apatite in remarkable quantity, black grains of magnetite, separate little crystals of hornblende, and augite. Occasional non-striated crystals might perhaps be orthoclase.

(2) Quartz is apparently rare, in irregularly outlined masses lying between the feldspar crystals, with numerous cavities which contain sometimes movable bubbles.

(3) Hornblende, of a dark greenish-brown color and strongly dichroitic; which is cut by cleavage planes that are either parallel or form an obtuse angle with each other. Its outlines are very irregular. Only the little crystallites which lie scattered in the plagioclase, show sometimes regular forms.

(4) A dichroitic mineral (dichroitic in light green and red colors) appears in great quantity, perhaps even exceeding the hornblende in amount, which is colored light grayish-green to brownish-green. This differs from hornblende essentially, both in common light, on account of its bright colors, and between the Nicols by reason of its brilliant polarization, since hornblende appears very dark between crossed Nicols. It is either not at all fibrous, or slightly so, or completely fibrous. The fissures which cut it are generally irregular, and not entirely in right lines. Sometimes they run nearly parallel, and then pass through the fibrous structure nearly at right angles. But with a higher power a system of fine cleavage can be seen, which runs parallel with the fibrous structure. This latter is made apparent by the occurrence of fine parallel light or dark brown lamellæ and needles, but also partly by the existence of very fine cleavage lines. The outlines are very rarely entire, and preserved in lines. They are then quadratic and rectangular forms with imperfect or dulled corners: so that such a section could be produced only by the combination $\infty P.\ \infty P\infty\ \ \infty P\infty$ of augite, but not of hornblende. The fibrous structure and the fine linear cleavage run parallel to that line which corresponds to a plane $\infty P\infty$. Occasionally this mineral is more grayish-green, and little dichroitic. In spite of the dichroitic character of this mineral as seen in most of its individual grains, it cannot be considered hornblende, but must be referred to augite, possibly diallage. There are, moreover, in it fluid inclusions with movable bubbles.

(5) Rather frequent grains of magnetite are seen. These are more isolated, and are four or six angled.

(6) Apatite in extraordinary amounts, in fine needles, especially in the plagioclase, has been mentioned already.

(7) Yellow metallic opaque grains are certainly pyrite.

Chemical analysis of augite-dioryte No. 8 from Richmond.

Silica	52.00
Alumina	15.75
Sesquioxide of iron	3.55
Protoxide of iron	12.84
Calcium oxide	7.39
Magnesium oxide	3.42
Potassium oxide	1.24
Sodium oxide	3.37
Water	0.35
Carbonic acid	0.11
	100.02
Phosphoric acid	1.06

Hence it appears that this rock is richer in silica, protoxide of iron, phosphoric acid, and alkali than the foregoing, but poorer in lime, magnesia and alumina. Its combinations must therefore be different. The feldspar here appears the richer in soda, since the high content of soda comes in connection with a much lower amount of alumina. Hence the feldspar may in this case also belong in the acidic portion of the feldspar series. The potash ingredient corresponds to a per cent. of orthoclase at least of 7.33. The high amount of protoxide of iron must be attributed in part to the magnetite present, and partly to hornblende and diallage, because the rock is remarkably poor in magnesia. The large amount of phosphoric acid is a very distinctive character; it requires apatite to the amount of 2.59.

The fresh condition of the rock is evident here also in the small amounts of carbonic acid and water.

The second augite-dioryte from Richmond (No. 8) consists therefore of a compound of plagioclase (with perhaps some orthoclase), hornblende, diallage, magnetite, apatite, very little biotite, quartz and pyrite.

At Little Falls, furthermore, are distinct augite-diorytes, with several modifications, from the same range of rocks, each of which we will particularly describe.

9. *Augite dioryte (a) from Little Falls.* This rock constitutes a granular mixture of plagioclase, which is light-red to white, in small amount, and but slightly lustrous, very abundant black, shining, fibrous hornblende, in large crystals, and bright grayish-green augite, with parallel fibers. The last is also in less amount than the hornblende; it is dull, or slightly shining, and often has a border of shining hornblende. Occasionally, this min-

eral is somewhat more bright and lustrous, and then exhibits a very evident cleavage, which cuts directly through the indistinct boundary which outlines the border of the hornblende prism. These minerals, therefore, are regularly built upon each other, and the augitic mineral is diallage.

This stone contains no magnetite, since nothing can be drawn from its powder with a magnet. Furthermore, titanic iron is not present, inasmuch as in the same powder no metallic residue is found on washing.

Biotite appears only very rarely.

Under the microscope the rock shows the following composition :

(1) Feldspars, which appear mostly as aggregates of smaller crystals. They are generally striated, but often the striation can not be distinguished, especially if they are filled with a gray granular substance. Sometimes there is only a narrow border that is free from this granular structure, while the inner portion is filled with it.

(2) Quartz appears only subordinately, and in small, crowded pieces.

(3) Hornblende is in larger, generally clustered, united crystals, whose outer borders are sometimes regular and sometimes irregular. They are of a greenish-brown color, strongly dichroitic between crossed Nicols, showing brilliant colors, are plainly cleavable, and are rich in inclusions of granular plagioclase and little crystals. Sometimes in polarized light they exhibit twinning lines, by means of which one crystal is separated into two parts placed closely alongside of each other, which show different polarization colors. Sometimes on the border of these are several narrow lamellæ, so that in place of one of the twinning-bands may be seen several very fine color-bands.

(4) Augite appears in the thin section much more abundant than in the hand sample. It is mostly grouped in clusters of several crystals, generally by itself, but sometimes intimately connected with hornblende. It is partly entirely colorless, and partly colored bright green, in one place very pure, and in another having a gray granular substance or dark yellowish-brown spots of hydrated iron oxide, with which indeed it is often wholly filled. It appears either wholly compact, or cut through by numberless clefts, which are sometimes parallel, but also run sometimes very irregularly. The augitic mineral is but little or not at all dichroitic,

shows bright polarization colors, is very frequently perfectly fibrous, and has irregular outlines.

(5) Here and there appear short prismatic crystals, about 0.18 mm. thick, with regular six-sided outlines, and often numerous diagonal cleavage-lines parallel to the plan oP, which would hardly be taken at the first glance for apatite, because they are short and thick. Inasmuch as this mineral, which is soluble in acids, gives no cubic precipitate of salt with concentrated hydrochloric acid, but with sulphuric acid a lime reaction, and with molybdic acid a phosphorous reaction, it must be apatite. Slender crystals of the same, moreover, also occasionally are found.

(6) Some black metallic grains, very sparsely distributed, and of irregular form, are probably magnetite or titanic iron.

The chemical analysis of the augite-dioryte, No. 9, gave the following :

Silica	46.52
Alumina	13.87
Sesquioxide of iron	3.71
Protoxide of iron	8.79
Lime	11.00
Magnesia	10.04
Potash	1.01
Soda	2.13
Water	1.05
Carbonic acid	0.47
Total	98.59
Phosphoric acid	0.32

The rock is, therefore, a very basic one, notwithstanding its content of quartz, and is remarkable for its high percentage of magnesia, lime, and protoxide of iron, owing to the predominating abundance of hornblende. But since generally hornblende contains more magnesia than lime, and diallage is present in too small quantity to lay any claim to the amount of lime indicated, a part of the lime must belong to the plagioclase. Hence it might be concluded, from the petty amount of quartz seen in the thin section, that the plagioclase comes nearer anorthite than albite. The small percentage of potash in the rock might be referred to the presence of orthoclase, amounting at most to 5.96 per cent.; but is more probably only an accidental ingredient of the plagioclase. The content of apatite amounts to 0.78 per cent. That the rock is not entirely unchanged is shown by the presence of water and carbonic acid.

The augite-dioryte No. 9, from Little Falls, consists, therefore, of a basic plagioclase (perhaps with some orthoclase) very much hornblende, some diallage, isolated large apatite crystals, a very little quartz and biotite, and a very small quantity of magnetite and titanic iron.

10 *Augite-dioryte (b) of Little Falls.* Like the foregoing, this rock also consists of a granular mass; embracing abundant, brightly lustrous, black hornblende; white to reddish fine grained feldspar on the cleavage planes of which there can be seen generally no twinning lines; scattered gray quartz; occasional scales of biotite, and specks of pyrite, as well as a light-grayish-green to light-brown augitic mineral which has a border of lustrous hornblende, but which is very much changed. For that reason although the relation of its cleavage-planes to those of the hornblende-band surrounding it cannot be learned with certainty, yet it has the appearance here as if the cleavage-planes of the augite cut off the cleavage edges of the hornblende; and hence the mineral can be considered diallage.

Under the microscope can be seen occasionally rather large, apparently pure crystals without any trace of striation. These can probably be considered orthoclase. This mineral embraces sometimes numerous gray or white grains, so thickly crowded that it becomes now translucent. The triclinic feldspars appear in numerous smaller crystals which often are apparently pure, but also are filled sometimes with grayish grains. Quartz appears scattered in larger or smaller kernels embraced between the crystals of feldspar; it is uncommonly rich in fluid-inclusions of many forms, and often with rapidly moving bubbles. The hornblende is of a green-brown color. It is strongly dichroic, and in all respects as in number 9. The augite is rarely visible. It forms the center of hornblende crystals, is either light-greenish-gray, nearly colorless and non-dichroic, or green, granular and fibrous, and then somewhat dichroic; and is cut by irregular fracture lines. Quite common are isolated crystals of apatite, which have a thickness exceeding 0.2 mm. They can be distinguished by the reactions already mentioned. Brown biotite scales, as well as black grains of magnitite or of titaniferous iron, are rare.

The chemical analysis of the augite-dioryte No. 10 gave the following result.

SiO_2	52.35	
Al_2O_3	15.72	
Fe_2O_3	2.90	
FeO	7.32	
CaO	8.98	
MgO	7.36	
K_2O	1.32	(with a small trace of Li_2O)
Na_2O	2.81	
H_2O	1.35	
CO_2	0.23	
	101.34	
P_2O_5	0.30	

The higher content of silica in this rock above the former is in consequence of the greater amount of quartz present. That the amount of orthoclase cannot be very great is shown by the small amount of potash. It reaches therefore not to exceed 7.8 per cent. The lower percentage of lime and magnesia in comparison with No. 9 is in consonance with a somewhat less amount of hornblende, and perhaps also with a lower amount of lime in the plagioclase. The apatite reaches 0.73 of the rock.

Augite-dioryte No. 10 consists therefore of plagioclase, probably some orthoclase, some quartz, much hornblende, a litte diallage, a very little apatite, biotite and magnetite or titanic iron.

11. *Augite-dioryte (c) from Little Falls.* Makes a medium-grained mass of white, triclinic feldspar whose striation cannot always be distinguished; abundant hornblende; bright grayish-green to bright-green diallage, which appears to be present in but small amount, and rather frequent brown scales of biotite.

Under the microscope it can be seen that the feldspar is generally striated, and that it is pure and clear only about its edges, but its interior is filled with granular substance; that quartz is but seldom present, and the hornblende is the same as in Nos. 9 and 10. The diallage is colored light-green, or flecked with light and darker green. It is sometimes as grains in the center of hornblende, sometimes regularly connected with it, and sometimes existing alone in the feldspar. Sometimes the external borders of the crystals are formed so sharply that they could be measured. The angle found amounted to about 137°, which answers to the angle $\infty P : \infty \bar{P} \infty$ of augite. The diallage is not in the least dichroic; it is cut by fissures that run sometimes parallel to the long axis of the crystal, and sometimes in every direction. Diallage here is found in remarkably large amount, so that it falls but little below hornblende. Sometimes are seen bright greenish brown scales of biotite; finally, apatite appears in short thick crystals, and long slender needles.

The augite-dioryte, No. 11, differs, therefore, from No. 9 and No. 10, especially in its richness in diallage.

12. *Feldspathic augite-dioryte* (*d*) *from Little Falls.*—This rock consists macroscopically, of a medium-grained mass made up of an abundant white or grayish-white feldspar, which appears very dense ; that is to say, like a dense mass of very fine grains of feldspar, and of black, brightly lustrous elongated crystals of hornblende, which, however, is less abundant than the feldspar. Mingled with both these principal ingredients is a bright green augite, which forms the central kernel in the hornblende grains. Unfortunately, the cleavage of the augite is not sufficiently evident to show with certainty whether there is a regular passage in the hornblende. Quartz and biotite are not present.

Under the microscope it can be seen at once that the feldspar consists constantly of very numerous small crystals intact on all sides, generally showing a clear, bright, narrow border, and an impure center filled with a gray granular substance. Border and center are sharply defined, especially in polarized light, and the boundary corresponds exactly with the outer surface. Both are triclinic uniformly, and it is seldom that no twinning-striation can be distinguished.

Embraced between the feldspar crystals can be seen, much more rarely, isolated segregations of quartz, which contain fluid-inclusions with moving bubbles.

The hornblende appears brownish-green, is strongly dichroic, and suffers on all sides from the encroachments of the forms of the feldspar crystals, so that but few opportunities are found to see the natural borders of the hornblende itself. Many crystalline grains of plagioclase are also included.

The augite is quite colorless, or light-green. It appears only as kernels within the hornblende, and is pierced with fissures that are nearly parallel, or wholly irregular, It is not dichroic, generally very pure, but embraces dark, granular impurities along some of its fissures and on its edges. The surrounding band of hornblende generally is complete for each individual.

Apatite appears, sometimes in thick and sometimes in needle shaped crystals, which often are in groups.

Small scattered grains that are opaque and have a metallic luster, are probably magnetite or titanic iron.

The chemical composition of augite-dioryte No. 12 is as follows:

SiO_2	51.27	
Al_2O_3	23.72	
Fe_2O_3	1.35	
FeO	3.81	
CaO	10.50	
MgO	3.30	
K_2O	0.65	
Na_2O	3.35	(with a very small trace of Li_2O)
H_2O	1.23	
CO_2	0.35	
	99.53	
P_2O_5	0.37	

This rock contains, notwithstanding its scattered grains of free quartz, only a low percentage of silica. The high percentage of alumina and lime corresponds with its large amount of lime-feldspar; that this is not anorthite is declared by the percentage of soda. The plagioclase hence comes very near labradorite. Orthoclase appears to be wanting—the small amount of potash could be embraced in the triclinic feldspar; it would at the most require a percentage of 3.84 of orthoclase. The small amount of magnesia gives a datum for calculating the amount of hornblende in the rock. Apatite reaches 0.90 per cent. Notwithstanding its very fresh appearance, this rock still has evidently some contained water and carbonic acid.

The augite-dioryte No. 12 consists, therefore, of plagioclase, hornblende, augite (probably diallage), a little quartz, very little magnetite or titanic iron, and apatite.

According to the foregoing the augite-diorytes consist, in general, of a combination of plagioclase, which approaches nearest to labradorite (perhaps with some orthoclase), hornblende, which very commonly is associated with and regularly changed into diallage, biotite, magnetite (perhaps occasionally a little titanic iron), and apatite; along with which only a very small amount of quartz is also embraced. The rock approaches hornblende-gabbro, but is very poor in augite; which, however, can be observed in the form of diallage, though not in all cases, while true hornblende-gabbro contains very distinct diallage in noticeable quantity, as well as a large amount of magnetite and titanic iron, which is not the case with augite-dioryte.

Accompanying the diorytes from Little Falls (and appearing in that vicinity) is a rock which perhaps is only a modification of the same species, though it differs from them in several particulars; so that it possibly may be pronounced another rock. More exact investigation in the region and *in situ* can alone determine this. It therefore will provisionally be classed as an augite-dioryte.

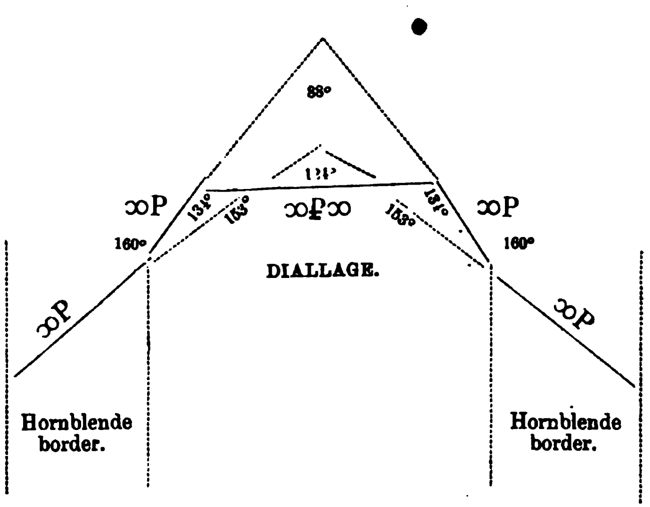
13. *Augite-dioryte* (*e*) *from Little Falls.*

This singular rock appears, macroscopically, to consist of a medium-grained assemblage of the following minerals:

(1) Feldspar grains of a bright yellowish-gray, or dirty-white color, sometimes reflecting the light brightly, though principally but slightly lustrous; for the most part with evident twinning-striation, rarely without it.

(2) Diallage. This mineral is present in very large amount, sometimes in rather small grains, sometimes also in large individual crystals, with four angles, eight to ten millimeters in size. It is of a light green, or brownish-green, or yellowish-green color, lustrous or but slightly so, often only shimmering; it fuses with some difficulty in thin slivers, under a feeble flame, to a grayish-green glass; and possesses three rather evident cleavage-directions. Those two that are less evident form with each other an angle of about 88 degrees. That which is most distinct cuts directly across the apex of the other two, that is, it forms with each of them an angle of about 134 degrees. Should the two former planes be considered ∞P, then the principal cleavage-plane would be equal to $\infty \bar{P} \infty$, as is the case in other diallages. The fusibility of the mineral prevents its being styled enstatite; if it were hypersthene it would be fusible with more difficulty, also the color of the bead would show a high content of iron, which is not the case. It must therefore be pronounced diallage, of which, it is true, the principal cleavage-plane is generally far more perfect than in this mineral, while the tendency of cleavage in accordance with the columnar planes is usually hard to distinguish, though here it is quite prominent.

This diallage here never appears alone, but it is constantly furnished with a lustrous brownish-black border of hornblende, which grows upon the central grain of diallage in such a manner that the cleavage-plane $\infty \bar{P} \infty$ of the latter exactly forms a right angle with the columnar planes of the hornblende — that is to say, forms an angle in both directions with the cleavage-planes of the hornblende of about 153 degrees, while these latter make external angles of 160–161 degrees with the cleavage-planes ∞P of the diallage, as can be seen in the following diagram:



The width of this border of hornblende is very variable; sometimes it is very narrow, in other places it is wider, even so wide that but a very small nucleus of diallage remains. Here obviously the hornblende results from the diallage, and it is possible that wherever hornblende, in the rock, exists without a central grain of diallage, it may also have been produced from diallage, because it differs in no respect from the hornblende borders. Unfortunately, it was not possible to extract a sufficient quantity of the diallage, free from hornblende, for analysis of each separately.

(3) Hornblende. This appears sometimes alone, and sometimes as borders about the diallage. It is present in large quantity, of a brownish-black color, brightly lustrous, fibrous, and plainly cleavable.

(4) Biotite, in numerous, brightly-lustrous scales, of a dark-brown color.

(5.) Quartz can be distinguished with certainty, in light gray grains.

The microscopic examination gave the following result:

The feldspars, in by far the greater number of cases, are marked by very beautiful, remarkably distinct, lines of twinning striation. They are tolerably pure, and contain generally only small, irregular specks and scales, but at the same time also granular aggregations which often form an inner nucleus with a distinct outline, parallel with the outer clear border, and especially when the twinning lines are wanting. Sometimes these crystals, particularly the impure ones, are formed of successive layers, each layer being very thin, placed over each other like numerous laminæ ; which have the deceptive appearance of a twinning striation; and since the stone has a high percentage of potash, one would be justified in considering these feldspars without twinning lines as orthoclose.

The hornblende is brown, sometimes also green, in the latter case impregnated with viridite, strongly dichroic, cut either with parallel cleavage, or with systems of cleavage, that make an angle with themselves of about 125 degrees. The outlines of the hornblende are sometimes very irregular; especially in the larger grains that are associated with diallage ; for the most part exhibit the forms of long, slender, rather straight crystals (cut lengthwise,) in which, however, cannot be seen the characteristic form of hornblende ; sometimes thin sections appear, though not often, accidentally parallel to oP, in which the sides run parallel to the cleavage lines, which intersect each other at 125 degrees. These are, therefore, forms that are peculiar only to hornblende, and they cannot be present in augitic minerals. Such hornblendes, therefore, are in no case secondary products of change from augite, because they are present in their own forms.*

Diallage is visible almost entirely as internal central grains within the hornblendes. It is then colored very light-green, or is colorless, but sometimes also darker green by reason of a mingling of viridite; it is not dichroic, but shows between the Nicols bright polarization colors. It is cut by fissures which seldom are parallel to each other, but for the most part run very regularly. The hornblende borders either form somewhat large crystallites lying thickly upon each other, or consist of a fibrous collection mingled with diallage and filled with viridite, or they are formed very perfectly so that the individuals that constitute them have everywhere a parallel position. The regular outline is lost where it adjoins the diallage, as it is continually and very irregularly changing outward and inward, in proportion as the hornblende encroaches more or less on the augite; indeed it advances along the fissures very much like veins far into the interior of the diallage, so that one cannot escape the conviction that the hornblende is here a product of change fróm the diallage. This conviction might also be made more general, so as to hold the smaller hornblende crystals as completely changed augite; contrary to which however the fact remains that these smaller hornblende crystals have their own independent forms.

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* Compare, however, more recent statements by Prof. Irving—*Am. Jour. Science and Arts*, 1883.—N. H. W.

It is necessary therefore to conclude that the hornblende in this rock is sometimes an original and sometimes a secondary product.

The diallage sometimes is twinned, several wide laminæ alternating with each other conformably to the orthopinacoid. Parallel to this twinning the first fissures run.

Magnetite, or titanic iron appears but very rarely.

On the other hand quartz is rather abundant, embraced between the straight borders of the feldspar crystals. It is also here very pure, and contains fluid-inclusions in which, however, but very rarely can be seen any moving bubbles.

The apatite crystallites are narrow and long. as well as short and wide, and rather abundant. The latter would be known as apatite by their chemical reaction.

Biotite is known by its dark greenish-brown, entirely non-translucent plates, which have always an irregular outline.

The augite dioryte No. 13, from Little Falls has the following composition :

SiO_2	56.49	
Al_2O_3	17.49	
Fe_2O_3	3.51	
FeO	3.72	
CaO	6.64	
MgO	4.01	
K_2O	3.20	(with a trace of Li_2O)
Na_2O	4.49	
H_2O	1.14	
CO_2	trace	
	101.19	
P_2O_5	0.18	

Here it appears, at the outset, that this rock no more belongs to the class of basic rocks than the foregoing rocks, but, indeed, has a content of silica somewhat higher, because, as has been found, it possesses a notable amount of free quartz. The small quantity of iron is due to the presence of a little magnetite or titanic iron. Very noticeable is the high percentage of potash, which, if it were turned entirely to the formation of orthoclase, would supply to the rock a percentage of 18.92 of this mineral, which would be nearly one-fifth of the whole. But the microscopic examination teaches that by far the largest part of the feldspar is plagioclase, and that only a few of the larger crystals consist of orthoclase. Therefore, it appears that a large part of the potash must belong to the plagioclase. The small amount of lime seen in the rock is divided between diallage and hornblende on the one side, and the plagioclase on the other. To the latter, therefore, belongs only a portion of the lime present, but nearly the whole of the soda, amounting to 4.49 per cent., to which also a part of the potash must be added. The plagioclase, therefore, which composes a predominant portion of the rock, is rich in alkali, and comparatively poor in lime ; it will, therefore, come nearer to albite than to anorthite, and it would not be amiss if it should be reckoned as oligoclase, or perhaps, as andesite. That diallage and hornblende are less in amount than feldspar, is shown by the low percentage of magnesia. As there is almost no magnetite nor titanic iron, nearly the whole of the iron-oxide is due to the diallage and hornblende, which also lay claim to a part of the lime, and very likely, also a part of the soda. Apatite reaches 0 44 per cent.

The augite-dioryte (*e*) *from Little Falls, No. 13 consists, therefore, of plagioclase* (*oligoclase or andesite*), *some orthoclase and quartz, of hornblende and diallage, intimately associated with each other, biotite, a very little apatite, magnetite or titanic iron.* The rock is distinct therefore, in its mineralogical and chemical composition, from the other augite-diorytes from Little Falls by reason of its high per centage of silica, its comparative richness in quartz, its content of potash and orthoclase, as well as of oligoclase and andesite, while the rocks of the vicinity contain labradorite, at least a basic plagioclase, and finally by reason of its greater richness in diallage. In consequence of which this rock is related to hornblende-gabbro by reason of its diallage, to augite-quartz-dioryte by its containing quartz, but to the syenitic rocks by its containing quartz and orthoclase. Therefore there might be a temptation to separate it from the augite-diorytes, as a different rock, standing between syenite and gabbro. The fact that the augite-diorytes from Little Falls are themselves very changeable in their composition. and that the rock in question appears to be associated with them, was sufficient, instead, to determine us to unite it *provisionally* to the augite-diorytes.

IV. QUARTZ-DIORYTE.

This rock occurs at Sauk Center and Little Falls, at the latter place, though, only in a few limited courses in the midst of mica schists.

14. *Quartz-dioryte from Sauk Center.* This comprises, macroscopically, a medium grained mixture of the following minerals.

Feldspar is generally grayish-white, sometimes brightly lustrous, but generally dull and not very fresh. Wherever the principal cleavage-plane is sufficiently bright the twinning-striation can be seen, and hence the feldspar seems to be triclinic.

Quartz is abundant in gray, irregularly shaped grains.

Hornblende is of a dark brownish-black color, but not so strongly lustrous as other fresh hornblendes. It is fibrous, and only rarely appears in independent grains, but generally in groups. In amount it is about the same as the feldspar.

Titanic iron is in very small, dark gray, nearly black, grains, with a black metallic luster. In order to determine this mineral with care the powdered rock was carefully washed. The last remaining grains, with metallic luster, were, it is true, somewhat magnetic, but they gave before the blow-pipe an evident titanium reaction, and were entirely insoluble in muriatic acid.

Pyrite in scattered specks.

Epidote in secretions that are small, scattered, and of a bright green color.

The microscopic examination gave the following :

The feldspar is for the most part only translucent, and is filled with a white granular mass. These granular inclusions also generally obscure the color lines in polarized light, which, nevertheless, here and there come out very evident. The mineral therefore might be taken either for a triclinic feldspar or orthoclase. But the latter certainly can be present in only very small quantity, on account of the small percentage (1.02) of potash found in the aggregate analysis. But the feldspar contains, besides the fine white grains, also very numerous green grains and scales of a substance like viridite.

The hornblende appears in dark-brown, or greenish-brown individuals generally bounded by right lines, or irregular groups of the same. It is strongly dichroic, cut by numerous cleavages, which are parallel or so directed as to intersect each other at obtuse angles. Sometimes it shows itself in linear or nettedly-fibrous aggregates, which often are crowded with viriditic substance. This granular viriditic substance also encroaches on the hornblende in so large masses, in some parts, that it is no longer recognizable. The hornblende here also sometimes contains frequent cavities with movable bubbles.

It would seem as if here also, in some of the hornblendic grains, an augite center exists, and in some cases the center acts, especially in polarized light, differently from the border. But, as in these cases the inner portion is often filled with viridite, it is impossible to know the presence of augite with absolute certainty, though it can be considered very probable.

The quartz is embraced between the feldspar and hornblende crystals in considerable amount, but appears also sometimes in original hexagonal outlines. It contains rarely numerous pores and little sacks, with movable bubbles, or with colorless cubes, or with both at the same time; rarely with many needles of apatite, and sometimes inclusions of viridite.

Epidote is of a light greenish-yellow color, and at the same time but little dichroic, but shows between the Nicols lively polarization-colors. In direct light, it appears yellowish-white. Generally it is pierced by numerous irregular, very fine cracks and cleavages, and often is tolerably pure; yet very often grains of viridite show themselves, sometimes entirely filling it. Likewise, sometimes, brownish-colored or fine gray grains are very numerous in it. The outer boundary of the epidote is very seldom straight, but on the contrary, very jagged.

The titanic iron is quite often in six-sided individuals, sometimes in groups.

Also, apatite is in comparatively large amount, being, indeed, in all parts; it is sometimes in fine needles, sometimes in rather large crystals, over two-tenths of a millimeter long and seven-hundredths of a millimeter wide, or in hexagonal thin-sections. Not only does the angle P : ∞ P, which many times was determined at about 130 degrees, identify this mineral as apatite, but also its chemical reaction. The larger crystals are not pure, but show numerous small cavities, though without bubbles.

The chemical composition of the quartz-dioryte No. 14, is as follows:

SiO_2	56.59
Al_2O_3	12.41
Fe_2O_3	5.39
FeO	10.28
CaO	6.70
MgO	2.02
K_2O	1.02

Na_2O	4.27
H_2O	1.45
CO_2	trace.
	100.13
P_2O_5	0.44
TiO_2	0.22

The following conclusions result from this analysis :

The low percentage of potash points to a small per cent. of orthoclase (at most 6.03), if all the potash is not embraced in with the triclinic feldspar. The comparatively high percentage of soda, and the small amount of lime, which latter belongs in part to the hornblende, the epidote and apatite, point conclusively to the presence of a feldspar rich in soda and poor in lime, which therefore will come near to andesite or oligoclase. Although the hornblende is present in notable amount, yet there is only a low percentage of magnesia. It must therefore be poor in this respect. But, also, it cannot contain much lime, which is claimed partly by the other minerals. Consequently it must be very rich in iron-oxide, and perhaps contains also some soda. Very remarkable is the low percentage of silica, notwithstanding the presence of a notable amount of quartz. This can only be accounted for in that the hornblende is poor in silica, and that through the presence of titanic iron the percentage of silica of the whole rock is reduced. The apatite amounts to 1.07 of the rock. Without regard to the appearance of the individual minerals, the water present amounting to 1.45, shows that the rock is no longer entirely fresh.

The foregoing examination teaches that the quartz-dioryte No. 14, from Sauk Center, consists of a mingling of plagioclase (andesite or oligoclase), hornblende (apparantly sometimes with an augitic center), and quartz, in medium-sized grains, with which are found, in subordinate amounts, orthoclase (doubtfully), epidote, titanic-iron, apatite, and a very little pyrite.

15. *Quartz-dioryte from Litlle Falls.* This rock consists, macroscopically, of a coarse-grained mixture of the following minerals.

(1) Black hornblende. The crystals are frequently perfectly formed, so that notably the planes ∞P and $\infty \breve{P} \infty$ are nearly everywhere plainly visible, according as one or the other is displayed tabularly, while the terminal planes are wanting. They are fibrous, and therefore but slightly lustrous, or merely shimmering. Before the blow-pipe the hornblende fuses, after a slight intumescence, to a black glass.

(2) A dense fine-grained gray mass, apparently consisting of an impure, dense, or rather fine grained crystalline feldspar, which only fills the interstices between the hornblende crystals.

(3) Quite frequently are seen scattered, well formed rhombic dodecahedrons of brownish-red garnet.

The pulverized rock contains no trace of a magnetic substance. In the slime appear no heavy, black, metallic grains, but only light flakes of biotite.

With the microscope, the following can be discerned :

(1) The hornblende crystals are very sharp, and wholly bounded by right lines. They are sometimes of a greenish brown color, and then they are strongly dichroic; or they are green, and appear flecked, apparently impregnated with viridite, and then they are less dichroic, but yet more strongly than the augite. A difference between the inside and the outer border cannot be discovered. This hornblende is now possessed of numerous inclusions, among which appear, particularly, colorless angular kernels of quartz, as well as of feldspar. Hence, the mineral appears, especially between crossed Nicols, like a sieve, in which the hornblende looks very black, but the abundant included grains shine out in variegated colors. The hornblende is cut sometimes by parallel cleavage running lengthwise, and sometimes by very fine irregular fissures.

(2) Between these regularly developed crystals of hornblende is a fine-grained aggregate of quartz, feldspar, and of little black angular grains, that are sometimes also brown. The quartz grains are small, very clear, and with very few cavities. The feldspar makes little irregularly angular kernels which cannot be distinguished, as to whether monoclinic or triclinic. What the abundant opaque black specks consist of could not be determined more exactly. The translucent brown grains, or blades, certainly were biotite. Very slender, minute needles of apatite were very sparingly visible.

(3) Regularly six-sided, or quadratic, bright red crystals of garnet. It is penetrated by irregular fissures, and embraces irregularly-shaped gray grains, and also cavities of the same form.

(4) There are also a very few scattered black metallic secretions, perhaps some of titanic iron, the forms of which are very various.

The following shows the chemical composition of the quartz-dioryte No. 15, from Little Falls :

SiO_2	66.88
Al_2O_3	11.69

Fe_2O_3	1.68
FeO	8.94
CaO	5.45
MgO	3.55
K_2O	0.20
Na_2O	1.25
H_2O	1.03
CO_2	trace.
P_2O_5	trace.
	100.67

Very remarkable is the high per cent. of silica in this rock, which in connection with the low per cent. of alumina, shows that it is poor in feldspars and rich in quartz. That the feldspars are plagioclase is evident from the very low percentage of potash. As the rock contains very little magnesia and lime, but still much hornblende, this latter must be very rich in iron ; perhaps it contains also, further, alumina and soda.

The quartz-dioryte No. 15, from Little Falls, consists, therefore, of a mixture of large hornblende-crystals, between which is embraced a fine-grained aggregate of quartz, plagioclase, black grains and biotite. In it are found a few perfectly formed crystals of garnet, alongside of which the hornblende outlines fall away, and more rarely a very little apatite. Everywhere this rock appears in such relations as leave it doubtful whether it can be considered as an independent rock-formation.

V. AUGITE-QUARTZ-DIORYTE.

16. *Augite-quartz-dioryte* (*a*) *from Watab.*

Macroscopically this rock appears as a medium-grained mass made up of : —

(1) Triclinic feldspar of bright luster and very distinct striation ; (2) orthoclase, very fresh, and sometimes faintly red ; (3) irregular gray quartz grains ; (4) scattered black scales of biotite ; (5) greenish-black hornblende, not very bright, but in about equal abundance with the feldspar. Upon closer examination of the hornblende grains they can be seen frequently to contain a center of a diffierent nature. This is of a green color, shows no luster at all, though having a shimmering surface passing to dull, and possesses a more distinct cleavage, which forms an angle of about 153 degrees with the cleavage of the surrounding hornblende. The cleavage of the center therefore truncates the broad columnar edge of the hornblende; and hence here also the center consists of diallage.

Under the microscope can be seen, in the quartz, which is very abundant, along with the needles of apatite and crystallites, little fluid inclusions with and without bubbles, which often are in very lively movement. The orthoclase is rather impure by reason of many gray included grains; the same is true of the plagioclase the striation of which often appears particularly distinct by reason of lines of black specks. The biotite is in brown-translucent or opaque scales. Magnetite, or titanic iron, is rare. The hornblende constitutes light to dark brown crystals, that are cut by parallel cleavage but with imperfect outlines. Larger hornblende forms possess a center of augitic mineral, that is diallage. This is colored light yellowish-green, but becomes impure by reason of fine brown or opaque granular flecks, or even by brown-translucent scales of biotite or green grains of viridite. sometimes, distributed among these, can be seen little reddish scales with a faint metallic luster. It is wholly non-dichroic, sometimes is pierced by entirely systemless fissures, or is again very fibrous so that in its larger masses it looks like an assemblage of lighter and darker parallel fibers. Occasionally this mineral becomes dark green along the edge, and then passes into hornblende which everywhere encloses it. The surrounding hornblende sometines looks like an individual srystal, and makes hence no distinct line of separation from the diallage. Since this line appears distinct only in polarized light, it is then plainly seen to run out and in irregularly. Apatite appears in all parts, in slender and also in thick crystals.

Chemical composition of the augite-quartz-dioryte (*a*) No. 16, from Watab.

SiO_2	65.27
Al_2O_3	15.76
Fe_2O_3	1.36
FeO	3.44
CaO	3.70
MgO	2.14
K_2O	3.97
Na_2O	4.57
H_2O	0.42
	100.63
P_2O_5	0.26

From this it follows that the rock is still very fresh, inasmuch as it holds but little water, and no carbonic acid; further, that it must be placed with the acid rocks, that is to say, it accords in its composition with typical syenites, and especially in this respect comes near to the syenite-granite from Watab. The high percentage of silica is produced partly by its richness in orthoclase, and partly by its free quartz. The high content of soda of this rock, in connection with the low per cent. of potash, shows that the plagioclase will have to be one rich in soda and poor in lime, especially as a part of the lime is absorbed in the hornblende and the augite. But both these minerals can be present in comparatively small amounts, on account of the small per cent. not only of lime, but also of magnesia. The percentage of apatite reaches 0.59.

Notwithstanding this rock in its chemical composition is comparable with the syenite-granite from Sauk Rapids, yet its mineral composition shows a distinction from it. In the first place, it is the plainly visible presence of an amount of diallage in which the foregoing rock differs fróm syenite-granite. Further, its content of soda is greater than its potash, and the triclinic feldspar is paramount over the monoclinic. On the other hand, this rock differs from the augite-diorytes conspicuously in its content of free quartz, and from the quartz-diorytes by its containing orthoclase and diallage. It must, therefore, be separated from the above-named classes, as augite-quartz-dioryte. It could with equal reason be designated augite-quartz-syenite, so as to bring out its affinity to the syenites. But since a hornblendic rock with abundant plagioclase and a small amount of othoclase, is recognized as dioryte, and one with much orthoclase and little plagioclase, as syenite, it will be appropriate to designate the foregoing rock as an augite-quartz-dioryte.

The augite-quartz-dioryte (a) No. 16, from Watab, therefore, consists of a medium-grained assemblage of the following: plagioclase (oligoclase) orthoclase, quartz, hornblende, often furnished with a central nucleus of diallage, a little biotite, and a very little apatite, and magnetite or titanic iron.

17. *Augite-quartz-dioryte* (*b*) *from Watab.* This rock presents a somewhat different aspect from the last.

Macroscopically it seems to be a coarsed-grained collection of the following minerals: (1) red orthoclase; (2) white or reddish plagioclase, which is in greater amount than the last; (3) gray quartz in very irregularly shaped masses; (4) black hornblende which is present in large quantity. The crystals of this are generally fibrous and sometimes wholly filled with biotite. In it also are seen here and there little metallic grains in considerable amount. The crystals of the hornblende are rather strongly lustrous, but very frequently contain, within a lustrous border, a dull greenish-brown center with a cleavage that lies as the orthopinacoid of the hornblende, in which case it is possible to measure the angle which the prism-faces of the hornblende make with the cleavage of the central grain, amounting to 150–153 degrees. This center here also plainly consists of an augitic mineral with a very conspicuous cleavage, namely diallage. The fifth (5) ingredient is therefore diallage. (6) Biotite; this is found in scattered brown scales or in slightly lustrous aggregations, the latter when it encroaches on the hornblende: (7) Metallic grains, which appear sometimes in octahedrons, are magnetite; (8) Occasionally, even under the lens, long needles of apatite are distinguishable, both in the feldspar and in the hornblende.

By a microscopic examination the quartz is shown to be present in large amount. It contains many fluid inclusions, very often with movable bubbles. The feldspars are completely overstrewn and filled with grayish-white grains, so that they are often hardly transparent. As, therefore, the striation is obscured, it is impossible to determine whether orthoclase or plagioclase predominates. On the other hand, the twinning-striation frequently is indicated with the greatest distinctness; inasmuch as the included impurities, which consist either of fine grains, or of long, slender, slightly colored blades, that cut each other alternately like wedges, run in parallel lines, and by the regularity of this parallel arrangement give perfect expression to the twinning-striation. The hornblende crystals are greenish-brown or brown, and strongly dichroic, cut by parallel cleavage, and of irregular outlines. Sometimes they are penetrated by green viridite. The augitic mineral is generally in light-brown or dark-green crystals, but little dichroic, often very fibrous, and nearly always surrounded by hornblende. Between crossed Nicols, the fibrous structure becomes especially distinct as an irregular color-striation. This diallage is also often filled with viridite; and, further, it contains grayish-looking granular groups of elongated form and parallel structure, as well as dark-brown elongated entirely rod-like crystals, which likewise lie parallel. The hornblende border is sometimes very thin, and sometimes so wide that the diallage-nucleus occupies but a very small space. Sometimes this border is very regular, in so far as it pertains to a single individual. Often no distinct separation between the two minerals can be seen; it only appears in polarized light. Magnetite (or titanic iron) is in scattered grains or in irregular clusters, generally in connection with the hornblende. Biotite forms dark-green to brown, translucent or opaque plates. Apatite is evident in numerous large needles; and, finally, epidote and pyrite are very rarely seen.

The augite-dioryte (b) from Watab, No. 17, forms, therefore, a coarse-grained collection of plagioclase, orthoclase, quartz, hornblende, diallage; and connected with this, *biotite, magnetite (or titanic iron) and apatite, and very rarely epidote and pyrite.*

VI. SYENITE-GRANITE (HORNBLENDE-GRANITE).

This rock occurs at Sauk Rapids, St. Cloud, Watab, and Rockville on the Sauk river.

18. *Syenite-granite (a) from Sauk Rapids.* This rock consists, macroscopically, of a medium to coarse-grained collection of, (1) red and sometimes nearly colorless orthoclase, in which the cleavage surfaces are rather bright; (2) white, brightly-shining, triclinic feldspar; both these feldspars are very abundant; (3) quartz in the form of frequent gray grains; (4) scattered scales or clusters of brownish-black biotite; not frequent; (5) common hornblende, of a black color, in separate crystals, of irregular outlines, or in groups, often mixed with biotite. This hornblende, besides, plays only a subordinate role.

Microscopically one observes:—

(1) Orthoclase. This is very impure, often completely filled with very fine powder which consists of irregular brown and gray grains, but is not uniformly disseminated.

(2) Plagioclase. This is very often crossed by right lines of a black granular substance parallel to the twinning striation. This feldspar, besides, is everywhere filled with brown and gray grains.

(3) Quartz is present in large amount, in smaller and larger masses, sometimes only filling the interstices between the feldspar grains, and sometimes in apparently independent forms. It contains many fluid inclusions, with movable bubbles, more rarely long needles or short thick crystals of apatite, black specks, brown or greenish scales, and larger colorless crystallites with quadratic or rectangular cross-section.

(4) Dark brown to greenish-brown very dichroic hornblende, not very abundant. Sometimes this is completely opaque, and then appears black but with no metallic luster, and therefore filled with an opaque non-metallic substance.

(5) The plates of biotite are very seldom seen. They are mostly confined to the vicinity of the hornblende, and are concealed by the opaque masses.

(6) Magnetite in scattered grains (apparently octahedrons) is not abundant, and also adheres mostly to the hornblende.

(7) Apatite occures in nearly all the minerals in the form of long and short, thick and slender, crystals, which often show the planes oP, ∞P and P; also hexagonal cross sections are visible; these crystals are always very pure.

(8) Small, greenish-brown, pyramidal crystals, which were not more exactly determinable, come very rarely into view.

The chemical composition of the syenite-granite (*a*) from Sauk Rapids, No. 18, is as follows: —

SiO_2	67.70
Al_2O_3	16.11
Fe_2O_3	2.47
FeO	2.29
CaO	2.89
MgO	1.11
K_2O	4.47
Na_2O	3.64
H_2O	0.83
CO_2	trace
	101.44
P_2O_5	0.13

The high percentage of silica answers to the presence of a large amount of free quartz as well as of orthoclase (26.43 p. c.) which is indicated by the 4.47 of potash. Further, again, the tolerably high content of soda which is referable to an amount of triclinic albite, presupposes an equally high content of silica. This triclinic feldspar will come much nearer albite than anorthite, because in comparison with 3.64 p. c. of soda only 2.89 p. c. of lime is found in the whole rock, and a small part of this lime is needed for the hornblende. It would be entirely right therefore to consider the plagioclase as oligoclase. How little the hornblende is, is evident from the small percentage of magnesia and iron oxides, while the latter besides, take part in the forming of the magnetite. Apatite amounts to 0.32.

The syenite-granite (*a*) *from Sauk Rapids, No. 18, consists therefore of a medium to coarse-grained collection of orthoclase, oligoclase and quartz; with which are added, in subordinate amounts,* *hornblende, biotite, magnetite, apatite, and, very sparingly, scattered grains which are small pyramidal crystals of a greenish-brown color, not determinable.*

19. *Syenite-granite (b) from Sauk Rapids* is a rock of somewhat different appearance, coming from the same quarry. Macroscopically this rock differs from No. 18, only in the greater amount of change suffered by the larger masses of hornblende. These are tolerably soft, and have a light greenish-gray streak. Microscopically, the quartz is noticeable for the great numbers of fluid-inclusions with movable bubbles. At one spot could be seen a bright four-angled grain alongside of a movable bubble, which was tossed about by the bubble. It probably is chloride of sodium. The hornblende is converted partly into a green, viriditic mass, but is sometimes unchanged. In the midst of the dichroic brown hornblende is occasionally seen a nucleus not dichroic, greenish in color and filled with granular substance, which perhaps may be referred to some augitic mineral. A similar appearance is repeated in the same rock from another place.

20. *Syenite-granite from St. Cloud* consists macroscopically of a medium-grained mixture of orthoclase, plagioclase and quartz, as predominating ingredients, among which are seen scattered crystals of brownish-black hornblende in somewhat greater proportions than in the rocks from Sauk Rapids. In addition to these there are also little scales of biotite and occasionally a little pyrite. The larger hornblendes, which afford the identification of the six-sided outline of this mineral ($\infty P \,.\, \infty\underline{P}\infty$) and the angle of 125 degrees which the columnar sides make with each other, contain a center consisting of a green chloritic mass surrounded by a thin band of biotite. Between them still is seen hornblendic substance.

The microscopic conditions are like those of Nos. 18 and 19, though here were a few scattered hornblendes in which was a non-dichroic center which perhaps is derived from an augitic mineral.

21. *Syenite-granite between Sauk Rapids and St. Cloud.* This is also very similar to the above named; it contains, as can be seen by the unaided eye, in the greenish-black hornblende, a much decayed mineral of a yellowish-green to brown color, which can be recognized as augite. Very rarely a black mineral whose hardness is 6, can be seen, whose fracture is conchoidal and exhibits a strongly waxy or glassy luster, and which perhaps should be considered allanite or orthite.

22. *Porphyritic syenite-granite from Watab.* This rock has a

medium to a fine grained groundmass, with rather large crystals of red orthoclase which are surrounded sometimes by a band of plagioclase, The granular groundmass consists of quartz, red orthoclase and plagioclase, and greenish-black hornblende in subordinate amount.

Under the microscope the quartz contains numerous very fine fluid cavities, with and without bubbles, more rarely apatite, and green grains of hornblende. The orthoclase is for the most part, but especially in the large crystals, completely filled with brown or gray granular masses, and also embraces kernels and scales of hornblende. Plagioclase is but scatteringly seen. It is also very impure, filled with granular substance. The hornblende exhibits irregular outlines, has a brown or green color, is dichroic, fibrous, and appears mostly in small secretions, indeed principally in grains and scales in the quartz and feldspar. Black opaque grains are probably magnetite or titanic iron. Apatite is in slender needles in all portions.

The following is the chemical composition of the porphyritic syenite-granite from Watab, No. 22 :

SiO_2	70.05
Al_2O_3	15.04
Fe_2O_3	1.70
FeO	1.09
CaO	1.97
MgO	0.82
K_2O	5.09
Na_2O	4.77
H_2O	0.81
	101.34
P_2O_5	0.07

From which it appears that this rock belongs to the most acidic of this class, and that it is therefore rich in quartz. The orthoclase, reckoned from the content of potash, reaches 30.1 per cent. But the plagioclase is also found plentiful, as seems from the amount of soda present. As, furthermore, the rock contains but little lime this must come nearer albite than anorthite, and hence it is nearest to oligoclase. The low percentage of magnesia and iron-oxides is in accordance with the very small amount of hornblende.

All these rocks, therefore, having the composition of syenite-granite, consist of quartz, orthoclase, oligoclase, with a little hornblende, bio-

tite, apatite, and some magnetite or titanic iron. In the hornblende is sometimes a central mass which might be taken for augite. Sometimes these rocks are porphyritic.

These rocks are placed as syenite-granite or hornblendic-granite, and not syenite, for the reason that hornblende in them is very sparse, while the ingredients of granite are very abundant.

From this examination of the hornblende-bearing rocks of Minnesota it appears, as a common and important result, that there a whole class of basic and acid rocks is found, which, along with hornblende as an essential ingredient, contain also an augitic mineral, which, while subsisting, it is true, sometimes as an independent ingredient, is for the most part intimately connected with hornblende, indeed is entirely conformable to it in its mineralogical developement. This augitic mineral is present not only in the basic rocks, but also in the acidic which contain orthoclase and quartz; in the most acidic, it is true, it is only indicated, its presence here not being proved with certainty. This augitic mineral is found to consist everywhere of diallage, in which the most evident cleavage plane truncates the obtuse columnar edge of the hornblende that envelopes it. The association of these two minerals is one so irregular, the hornblende encroaches in so thin partings into the augitic substance, that one cannot resist the idea that here the hornblende is derived from the augite. The final proof of this view, however, will be produced when it has been pointed out that the outer envelop of the whole crystal takes upon itself the form of augite. Should this proof be attained, then it will be necessary to conclude that other hornblendes which no longer have an augitic center, have resulted from augite, and that in them the change has become completed — that is to say that the rocks under consideration were once still richer in augitic mineral than they now appear.

These rocks with diallage belong consequently to a group of the old rocks recently made known for the first time, in which augite and hornblende exist at the same time. Without mentioning the gabbro-rocks, in which the co-existence of these two minerals has been known for a long time, here belong the syenites from Scharfenstein described by Kalkowsky[1], also the augite-syenite from Monzoni which according to G. von Rath[2] has the hornblende as an accessory ingredient, but according to Doelter[3] in greater quantity than the augite. Von Rath[4] has stated also that at Laurvig a rock appears similar to augite-syenite, and the same investigator reports[5] that at LePrese the dioryte changes into gabbro by acquiring diallage. Here therefore the changed rock would correspond to augite-dioryte. The co-existence of augite and hornblende in the older rocks was also noted by Kürenz[6] in a dioryte at Trier, by Schmid[7] in a labradorite-dioryte from Ehrenberg, by Wiik in a dioryte-porphyry from Nokkala in Finnland, and in a dioryte-diabase[9] from Helsingfors ; by Mattesdorf[10] in a monzonyte from the Agnelloberg ; by Gümbel[11] in a rock of the Fichtelgebirg, by Tschermak[12] in a diabase from the Caucasus and in the melaphyrs[13] of the Fassathal[14].

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[1] Jahrb. 1876, p. 140. [2] Zeitschr, d.d. geol. Ges. XXVIII. p. 35.

VII. HORNBLENDE-LESS GRANITE.

This rock occurs at Watab, and at Coldspring, above Rockville, on the Sauk river.

The granite from Watab, which forms low hills at the entrance to the place, consists of a medium grained collection of quartz, grayish-white orthoclase which for the most part is in large crystals, grayish-white plagioclase and numerous scales of biotite.

The granite from Coldspring is porphyritic. Here lie coarse crystals of reddish orthoclase, white plagioclase and coarse grains of gray quartz, in a medium to fine grained groundmass which consists of quartz, much orthoclase, a little plagioclase and some biotite.

GIESSEN and HANNOVER, August, 1876.

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[3] Jahrb. d. k. k. geol. Reichs-Anstalt, 1875, XXV. p. 217. Verh. d. k. k. geol. Reichs-Anstalt, 1875, No 14, p. 247 ; No, 15, p. 289 ; No. 16, p. 304.

[4] Zeitschr d. d g. Ges. p. 358. [5] Pog. Ann. 114, p. 248, Anmerk.

[6] This Jahrb. 1876, p. 176 [7] Der Ehrenberg, p 19.

[8] This Jahrb. 1876, p. 209. [9] This Jahrbuch, 1876, p 208.

[10] Verh. d k. k. geol. R-A., 1876, No. 2, p. 33, [11] Dieses Jahrb. 1876, p. 436.

[12] Min. Mitth. 1876, p. 132.

[13] Porphyr-Gestine Œsterreichs, p. 124. See also Dœtler in Min. Mitth. 1875. p. 179, and Jahrb d. k k. g. R-A. 1875, p. 224.

[14] During the correction of the proofsheets I received a very interesting work from Rosenbusch, in which the evidence is given that in the variety of granite described by him as granityte, augite is not very rare, and sometimes is associated with hornblende to a remarkable extent in the granite-porphyries. Z. d. d. g. G. 1876, p. 369.

III.

NOTES OF ROCK-OUTCROPS IN CENTRAL MINNESOTA.

BY WARREN UPHAM.

The following pages record observations of the localities, extent, and most noticeable lithological characters of the crystalline rocks in the central part of the state, mostly in Morrison, Stearns and Benton counties; and of their few outcrops farther northwest in Todd county and the southwest corner of Cass county, and on the east in the northwest corner of Sherburne county and in Mille Lacs and Kanabec counties; with a description, also, of the sandstones and the copper-bearing trappean rocks, which lie next eastward in Kanabec, Pine and Chisago counties. This district is almost entirely drift-covered and heavily timbered. A map of it, showing the rock-outcrops here described, is presented on plate I. The detailed descriptions of the several counties are given in the following order: Cass, Todd, Morrison, Stearns, Sherburne, Benton, Mille Lacs, Kanabec, Pine and Chisago.

A large area in Stearns, Sherburne and Benton counties, including the valuable quarries of Saint Cloud, Haven, Sauk Rapids and Watab, consists of syenite and exhibits no laminated or gneissic structure. It has considerable variety in texture, as to its coarseness of grain and readiness to be quarried and wrought to any required form. Mostly its color is light gray, but upon some extensive tracts it has a red tint, similar to that of the celebrated granite of Aberdeen in Scotland. In other portions of this district, granite, gneiss and mica schist are the common rocks, sometimes associated with syenite. Their strike is usually to the northeast or east-northeast.

At Little Falls and Pike rapids, and for several miles to the south, west and north, as also at the mouth of Fish Trap brook in northern Todd county, is a group of rocks quite different from the foregoing, its range of variation being from a highly cleavable clay slate, and from a mica schist enclosing many crystals of staurolite and sometimes garnets and iron pyrites, to a very compact and tough, massive dioryte.

CASS COUNTY.

The only rock-outcrops known in Cass county are at Pokegama falls on the Mississippi river, described on page 195 of the ninth annual report; and those of T. 134, R. 32, the most southwest township of this county, about eighty miles southwest from Pokegama falls, and five miles northwest from Motley. The latter were first described by Professor Winchell on page 46 of the sixth annual report. The area of frequently outcropping rock at this locality reaches about a half-mile from south to north, and has a width of twenty to forty rods. It is mostly in the E.½ of the N.E.¼ of section 28, and extends north into the southeast part of the S. E. ¼ of section 21, and perhaps also beyond the lines of these into the adjoining sections 22 and 27 on the east. These outcrops in their southern part have a hight one to three feet, and in their middle and northern part five to eight feet, above the general surface of moderately undulating drift, being 20 to 40 feet above the Crow Wing river, which lies about three-fourths of a mile to the southwest. The only considerable elevation in this vicinity is a hill of glacial drift, extending a quarter of a mile from north to south, situated a short distance east of these ledges, in the west edge of the N. W. ¼ of section 27. This rises 40 to 50 feet above the rock exposures, and about 75 feet above the extensive marsh at its east side. Mainly the surface of this hill, as of the surrounding region, is sand and fine gravel, but boulders of granite up to five feet in diameter are found sparingly at its top and on its sides.

The greater part of the rock exposed here is gray syenite, rather fine-grained, containing both white and flesh-colored feldspar, and a greenish mineral, which last is sometimes most abundant in streaks or veins, up to two inches in width. Rarely two or three of these veins are seen within a foot, giving the rock a somewhat schistose structure. In the middle part of this area some of its ledges are granite, having principally a white feldspar, and including evident lumps of mica and also the green mineral of the syenite.

Two wide dikes of dark, tough, massive, trappean rock were noted. One of these, near the south end of this area, is visible for an extent of twelve or fifteen rods being fifty to sixty feet wide. The line of contact with the syenite on the northeast side of this dike is very distinct and sharply defined along its exposure two or three rods in extent, bearing S. 50° E. At the second dike, near the north end of these exposures, both lines of contact with the enclosing syenite are visible at many places along a distance of fully two hundred feet, bearing S. 70° E., which is the course of a conspicuous system of joints in the syenite. The width of this dike is thirty feet. From its northern side a branch of irregular course and varying from two feet to three inches in width reaches forty feet northerly, as shown in fig. 2, plate I. At one point seven or eight feet from the main dike, an offshoot from this branch is seen extending several feet with a width from one inch to only an eighth of an inch. The aspect of this dark eruptive rock is nearly the same in all portions; its line of contact, wherever exposed, is very sharply defined; and the syenite adjoining shows no notable difference from that at a greater distance. Some portions of the syenite and granite here may be found valuable for quarrying, which, though several times contemplated, has not yet been undertaken.

TODD COUNTY.

Only two localities of rock in place are known in this county. These are in the townships of Moran and Ward.

Moran. In the channel of the Long Prairie river at the mouth of Fish Trap brook and for a third of a mile along this brook next above its mouth, being in the west part of section 34, T. 133, R. 32, five miles southwest from Motley, are extensive outcrops of dark and tough, nearly black dioryte, resembling that found at "the point," about a half mile south of Little Falls. It is a very compact, coarsely crystalline rock, with no lamination or apparent tendency to split more readily in one direction than another. Some of the large blocks of this stone, lying in the bed of the Fish Trap brook near E. P. Jones' mill, which is an eighth of a mile above its mouth, ring sonorously like an iron kettle when struck by a hammer. This rock forms ledges one to four rods long, rising one to five feet above the water, in the channel of Long Prairie river and in both its banks at the mouth of this tributary, and at a few places for six or eight rods distance both above and below. Its outcrops along Fish Trap brook are seen at many places to Jones' mill, but above this for about a quarter of a mile are mostly covered by the mill-pond. Farther above, it has no exposure along this brook, which flows over glacial drift with many boulders and frequent rapids. In the vicinity of the mill its ledges occupy a width from two to four rods, and rise about twenty feet above the brook. It is mostly divided by joints from two to ten feet apart; but when Mr. Jones built his dam, he reports that he uncovered an extent of thirty feet of it without a seam. This rock is wholly worthless for quarrying because of its toughness to drill, and more especially because of the difficulty to bring it into any desired dimension. It is very hard to fracture and is evidently very durable.

Frequent outcrops of this rock, of small extent and hight, are reported within the next two miles eastward, in sections 34 and 35 and in the S. E. ¼ of section 36, also probably reaching across the township line, into the edge of the sections next south. Mr. Jones, who has explored this district, thinks that the only exception from the character of the rock as described, is a small belt seen at the the east side of Fish Trap brook, extending from the lumbermen's dam at its mouth a distance of about ten rods along the east shore of the pond. Here a nearly black slate is exposed, having its cleavage vertical or differing from this within a limit of five degrees upon each side. Its strike is N. 55° W., being parallel with the brook. The width of this slate visible is only from five to fifteen feet, and its contact with the neighboring dioryte is not seen.

Ward. The other rock-outcrop in Todd county is ten and a half miles farther southwest, lying nearly at the center of the N. E. ¼ of section 15, T. 131, R. 33, the west township of Ward. It is on land of Joseph Woell, a third of a mile west of Long Prairie river, and an eighth of a mile east of the road from Motley to Long Prairie, which here runs on the west edge of the valley-plain of modified drift. The extent of this ledge is some twenty rods from northwest to southeast, with a width of three or four rods, including several exposures, the longest of which reaches about a hundred feet. Their hight is from four to eight feet above the plain, which is about fifteen feet above the river. This rock, mostly quite uniform in composition, color, and texture throughout this area, is a bright-colored, medium-grained, gray syenite; containing about equal amounts of quartz, whitish feldspar, and dark, nearly black, hornblende; with a somewhat smaller proportion of a light-green mineral (probably epidote), in rather smaller grains than the foregoing. This seems to be the same mineral with that mentioned in the rock of Cass county, five miles northwest of Motley, and it is present as a principal ingredient of the rock in Ashley, Stearns county; but it has not been noted in other outcrops of these crystalline rocks. The whole ledge here has this mineral in nearly equal amount, the only exceptions being very rare concretions, one to two inches long and thin, composed of a dark-greenish micaceous mineral, and very rare seams or veins, a sixteenth to an eighth of an inch wide and a few feet long, composed of the light-green mineral which is generally disseminated through this rock. The only other vein or variety noted was a mass of coarsely crystalline, flesh-colored feldspar, exposed upon a patch of only about one foot, but probably forming part of a long vein, adjoining which the rock was more jointed and coarse-grained than ordinary. This ledge is generally intersected by nearly vertical joints, from two or three to eight feet apart. It has never been quarried, but will probably be found valuable for common masonry; and dimension stone, six to eight feet long, could be readily obtained. Though nowhere obviously schistose, the grains of this rock are all slightly prolonged in parallelism with each other.

MORRISON COUNTY.

This large and diversified county has many outcrops of the bed-rocks. Their prevailing types through the part of the county east of the Mississippi are granite, syenite, and gneiss. Along this river and farther west they are slate, staurolite-bearing mica schist, and dioryte. The former belong to a group which has its characteristic development in the syenites of Benton and Stearns counties, and in the granites and gneisses of the upper Minnesota valley. Though the geographical continuation of the second group of slate and associated rocks cannot be traced because of overlying drift, their lithological character shows them to be probably connected and of the same age with the slates of the lower part of the St. Louis river and its vicinity. The hydromica schists found in Carlton county near Moose Lake station may also belong to this second group.

It seems probable that the slate, staurolitic schist and dioryte of Morrison county, and of northern Todd county at and east from the mouth of Fish Trap brook, form a synclinal axis or basin bounded both east and west by formations of granite, syenite and gneiss.

In describing the ledges observed in Morrison county, these groups are treated of separately, the eastern, mostly granitic and gneissic rocks, which are believed to be the older, being first considered.

Buckman. This is T. 39, R. 30. Its only rock-outcrop, so far as learned of, is on land of A. B. Skinner, in the S. W. ¼ of the N. W. ¼ of section 18, a short distance east of the road which runs on the west line of the township, and north of a small creek. It is a coarse-grained, reddish syenite, nearly like that which occurs at many places in Sauk Rapids and Watab, Benton county. Several exposures of the rock are seen upon a space of about one acre, the largest being four rods long from north to south, and rising three or four feet above the general surface. Many blocks, four to fifteen feet in diameter, are scattered near.

Rich Prairie and vicinity. Proceeding northward toward the village of Rich Prairie, in Pierz township, the next exposure of rock is found about one and a fourth miles south of this village. It is at the east side of Skunk river, in the S. W. ¼ of section 17, on land of John Stumpf. Its area is equal to about forty feet square, and its hight is ten feet above the river. This rock is a gray granite, containing considerable black mica.

One and a half miles west from the last, and about a third of a mile south of Fish lake, upon the S. E. ¼ of section 13, T. 40, R. 31, is an outcrop of rock extending about fifteen rods from east to west and twelve rods from north to south, rising four or five feet above the general surface. Its eastern part is owned by Nicholas Meyer, and its west part by Anton Rauch. This is a fine-grained, light gray granite, very uniform in texture, with no veins or masses of other rock visible. It is divided by joints into beds one to two feet thick, dipping about 20° S., but it is not cut by vertical joints. It has been only slightly quarried, by Mr. Meyer for cellar walls. This stone has a pleasing color for building and monumental work, and a good degree of strength and durability. It is readily quarried in any dimensions that are ordinarily called for, and is easily cut or hammered. The ledge is valuable for quarrying, and a large excavation may be made without trouble from water, as the surrounding land is the porous sand and gravel of the modified drift; which also affords a nearly level and dry road for hauling the stone away.

About three miles southeast from Rich Prairie, exposures of the bed rock, probably granite, are reported to cover three or four acres, on land of Matthias Neuman, in the S. ½ of the N. E. ¼ of section 22. It has been slightly quarried.

One mile east of Rich Prairie or Pierz, the east bank of Skunk river between forty and eighty rods north of the mouth of Hillman brook, has frequent outcrops of gneiss, rising one to three feet above the general surface and ten to twenty feet above the stream, next to which they occupy a belt about six rods wide. This gneiss contains black mica and flesh-colored feldspar, the latter being sometimes gathered in layers or veins one to three inches wide. All these outcrops are more or less laminated, this structure being nearly vertical. They are all somewhat contorted and jointed. The strike is N. E. or N. 50° E., bearing in the direction of "Granite City," four miles distant, where similar gneiss has extensive exposures.

Along Hillman brook. In ascending this brook, my first observation of rock in place was at its lowest "roll dam," situated about three and a half miles above its mouth, in the north part of the N. W. ¼ of section 18, T. 40, R. 29. This outcrop is at the north end of the dam, and occupies an area about four rods long from north to south, by twenty to forty feet wide. Its southeastern two-thirds are gneiss, nearly like that last described, rather obscurely and contortedly foliated but indicating a N. E. to S. W. strike. This gneiss has much black mica and flesh-colored feldspar, and it is traversed by veins of this feldspar from an eighth of an inch to six inches wide. One of these veins, varying from three to six inches in width, nearly vertical, is visible for an extent of twenty feet in a straight east-to-west course. The joints of the gneiss are from two to ten feet apart.

The northwestern third of this ledge, extending within sight twenty feet from north to south and ten feet wide, is a fine-grained granite, containing much feldspar, which is partly gray and partly flesh-colored. This portion of the ledge is probably part of a dike or mass of erupted rock; it is rhomboidally divided by intersecting systems of joints, which are from two to twelve inches apart.

Ledges occur frequently in the vicinity of the second and third "roll dams," situated respectively about forty rods below and twenty rods above the mouth of the Little Hillman brook, tributary to the main stream from the south. About a mile above the mouth of the Little Hillman brook and a short distance, perhaps a quarter of a mile, above its dam, this stream is reported to flow some twenty rods in a gorge with walls of rock at each side, five to twenty feet high. Also, frequent outcrops of rock are found between these streams from their junction east and northeast to the "big dam" of Hillman brook.

This "big dam" is on the S. E. ¼ of section 35, T. 41, R. 29, about sixty rods west of its east line, and twenty rods south of its north line. Rock-outcrops of considerable extent occur at several places upon each side of the Hillman brook for a fourth or a third of a mile below and along an equal distance above the "big dam." These are gneiss and granite with the same characters as at "Granite City" and in the vicinity of Rich Prairie. Farther east the region drained by this brook and its tributaries has no known exposures of rock.

At the south end of this dam, about 400 feet south of the sluiceways, the gneiss is typical, including much black mica. Its coarse foliation is nearly vertical, with strike varying from N. 25°E. to N. 40° E. At the north end of the dam, 100 feet north of its sluices, the rock is a fine-grained gray granite, with black mica, nearly like that on land of Meyer and Rauch, south of Fish lake and a few miles southwest of Rich Prairie. This granite is here exposed upon an area which extends at least twenty rods east and ten rods west from the dam, and is from three to six rods wide. Mostly it is divided into rhomboidal masses from a few inches to four or five feet in dimension by joints, and no portion seen was sufficiently free from joints to yield large quarried blocks; yet it is quite likely that good quarry-stone would be obtained by excavating a few feet in depth. The texture and rift are nearly the same as south of Fish lake, to which this formation is probably continuous; the rock is equally compact and uniform in quality; and the color, though on the surface here weathered to a dull brownish tint, would probably be the same handsome gray as at Fish lake in deep quarrying.

"*Granite City.*" In the west part of section 21, T. 41, R. 29, on the northwest side of Skunk river, is the site where a steam saw-mill and a considerable town existed during several years next preceding the Indian outbreak of 1862. Its buildings remained empty from that time and were gradually removed or burned, the last continuing till 1873. The nearest farming immigrants are found about a half mile down the river, and from them northeastward the region drained by the upper part of the Skunk river and extending thence to Mille Lacs is an unbroken forest.

The rock outcropping at "Granite City," from which the name arose, is coarse, gray gneiss, containing much black mica. Its strike is from northeast to southwest, and its dip is vertical, or within a few degrees of it, being in some places 85° or 80° to the northwest, and elsewhere the same to the southeast. This rock forms numerous bare hillocks and ridges, ten to thirty feet above the Skunk river, for a fourth of a mile along its northwest side, and occurring in less amount on its southeast side. It is also seen on the southeast side in an exposure of a few acres, rising ten to twenty feet above the river at a fourth of a mile farther east. All these outcrops, so far as seen, are gneiss, everywhere more or less contorted, often quite twisted and bent in lamination for short spaces, but having throughout a prevailing N. E. to S. W. strike and nearly vertical dip. The Skunk river is here ten to twenty feet wide, and flows in a meandering course among these ledges.

About six miles above "Granite City," on the northwest side of Skunk river, a little beyond where this stream is crossed by the road used for carrying the supplies distributed yearly to the Mille Lacs Indians, rock exposures are reported to cover as large an area as at "Granite City," but to have less hight above the adjoining surface of the drift. This is in or near the northwest corner of T. 41, R. 28.

Near the Platte river. Numerous outcrops of rocks occur within one to two miles west of the Platte river through the six miles next north of Gravelville, which is an enterprising new village, with mills, situated on this river in the N. E. ¼ of the N. E. ¼ of section 35, T. 41, R. 31. The first of these ledges are one to two miles north of Gravelville, in the N. E. ¼ of section 26, the east edge of section 23, and the west part of section 24, T. 41, R. 31. The longest extent of this tract is from northeast to southwest, reaching a mile and probably including sixty to eighty acres of rock. In the N. E. ¼ of section 26 it is granite, sometimes pink and sometimes gray, rising eight or ten feet above the general surface, which is nearly level. In the W. ½ of the N. W. ¼ of section 24, these ledges rise ten to twenty feet above the adjoining swamps. The rock here is a dark gray gneiss, mostly obscure in its lamination. The strike, at least in part, is S. 70° W., but generally, because of the contorted and indistinct lamination, it is not clearly exhibited.

In the north part of section 18, on land of John F. Whitney, and in the adjoining south part of section 7, T. 41, R. 30, one and a half miles northeast from the last locality, are extensive exposures of the same dark gray gneiss last described. It contains considerable black mica. It is for the main part obscurely laminated, and, though nowhere a true granite, it is rarely so definite in its foliation as to show strike and dip. In some portions the strike is seen to be from north to south ; and the dip appears to be nearly vertical. Beginning near Mr. Whitney's house close to the center of section 18, frequent outcrops of this rock, rising one to five feet above the general surface, continue north to the north side of this section and into section 7. This section line crosses the most extensive of these tracts of rock, which covers some thirty acres, and here rises 25 or 30 feet above the adjoining swampy tracts. This gneiss has a nearly uniform character throughout the half mile here seen. Another outcrop of rock, probably the same, is reported one and a half miles farther north, near the center of section 6, covering about ten acres, and rising five to ten feet above the general surface. Three miles west from this a small ledge, covering five or six rods square, and one to three feet high, was found by surveyors near the middle of the north side of section 3, T. 41, R. 31, five miles east-northeast from Belle Prairie. Other ledges, which have not yet been observed, will probably be found in this district when its woods are cleared away. Thence northward to Brainerd and northeast to Mille Lacs, and beyond, no exposures of the bed-rock are known.

Slates, staurolite-bearing mica schist, and dioryte. The rocks which remain to be described in Morrison county, found along the Mississippi river and west of it, belong, as already stated, to a group lithologically different from the foregoing, and probably newer in age. The first exposure is on the Little Elk river near its mouth, about two and a half miles north of Little Falls. The most extensive outcrop here, about six rods square and ten feet in hight, is on the northeast side of the Little Elk river, opposite to Henry S. Hill's mill, about thirty rods above the mouth of this stream. This rock is dark, nearly black slate (argillyte), like that of Little Falls. It continues upon this northeast shore about ten rods down stream, southeastward, and for a few rods northwest above the dam; and is also visible in low exposures at the bridge, twenty rods above the mill. Opposite to the mill the course of the cleavage is N. 40° E. (referred, as are all the bearings stated in this paper, to the true meridian), and its dip is nearly vertical, varying to 80° S. E. This slate contains occasional veins of white quartz, from a quarter of an inch to two or three inches in width and one to twenty feet or more in length. These coincide closely with the cleavage in their strike and verticality. These slates throughout are rather soft and easily broken; and they are much divided, usually into rhomboidal masses from two or three inches to one foot in dimension, by joints. In one system of these joints, dipping about 60° S. E., they are mostly six to twelve inches apart in parallel planes. Other joints, dipping 20° to 45° to the north-northwest and from that to north, and a system dipping 15° W., are about half as numerous as those first mentioned. Another system of joints, cutting these, is vertical, or between vertical and dips of 60° to each side, with their strike between west-northwest and north-northwest. No macroscopic staurolite, garnet, nor pyrite crystals were noticed here, but distinct laminæ, made by aggregation of minute crystals of staurolite or mica, not fissile and extending transversely across the cleavage, are found in much of this rock, nearly as at Little Falls. These probably mark the original lines of stratification, but unfortunately their dip and strike here were not noted. The Mississippi river between this locality and Little Falls has numerous alluvial islands.

At the ferry, a half-mile above Little Falls, this slate has low outcrops two to six or rarely eight feet above the river. On the west side these are seen at several places for twenty rods below the ferry. On the east side they are best exhibited at the ferry-landing and for eight or ten rods farther north. The cleavage here bears N. 35° to 40° E., and is nearly vertical. Some four rods north of the landing a very compact layer occurs, ten feet thick, showing scarcely any slaty cleavage. About two rods farther north a quartz vein a foot wide was noted, conformable with the cleavage.

At the rapids, or Little Falls of the Mississippi, beside the town of this name, this dark slate, varying from mica schist to argillyte, has extensive outcrops in each shore, and forms the north end of Mill island, on the west side of which it makes a perpendicular cliff twenty feet high. The principal rapid extends a fifth of a mile from about 600 feet above this island to 500 feet below its north end, the descent being five feet. Here the slate has mainly a firm and strong texture, having been only slightly decomposed or softened by weathering; but it is too variable in its cleavage, and is too frequently contorted and intersected by veins and joints, to promise well for quarrying for roofing-slate. It has been slightly quarried on the east shore, nearly opposite to the north end of Mill island, for use in foundations, but no massive blocks nor any of regular form are obtainable. Its cleavage is usually quite perfect, into sheets a fourth or an eighth of an inch in thickness; it is nearly vertical, not varying from this more than five degrees to either side, so far as seen in my examination; and its strike is N. 25° to 35° E. A lamination transverse to the cleavage, and supposed to indicate the original planes of sedimentation, but not showing any tendency to split, was found well exhibited in a section twenty feet long and five feet high, at the outmost point beside the river on the east shore. The laminæ or layers referred to are from a twentieth to an eighth of an inch thick, and differ from the remainder of the macroscopically homogeneous slate in containing many minute crystals of staurolite and perhaps mica. These layers, which are very distinct, show many small undulations; but, in respect to their entire extent, run nearly in a straight line. Their dip is about 15 ° N.W. White quartz veins occur somewhat frequently in this slate, varying from an eighth of an inch to three inches in width, and extending from ten to fifty or seventy-five feet. Their strike and dip are conformable with the slaty cleavage. The thickest of these veins, situated in the channel of the river, is said to be one foot wide. In the east part of Little Falls this slate is encountered at the depth of about ten feet in digging wells; but it is not found thus in the west part, between this and its exposure at the river.

In some small portions of these outcrops the slaty cleavage is absent or scarcely noticeable, and the rock, massive, compact and hard, with sharp jointage angles, is apparently a dark quartzyte. Professor Winchell adds*: "Besides these variations there are nearly continuous layers of more or less lenticular and concretionary lumps or nodules, sometimes six or eight inches thick, of a rock very firm and dark-colored, but which on weathering becomes superficially lighter-colored, and shows needles and spangles of dark-green amphibole. The matrix in which these crystals lie is not well characterized, but is quartzitic and perhaps also feldspathic, so that on a fresh fracture the amphibole crystals are hardly observable. They appear on the weathering of the rock. . . . . A system of joints gives the rock, viewed across the river, the appearance of being conspicuously stratified, with a dip up the river of about 45 deg. from the horizon. The slatiness, which is nearly perpendicular, is somewhat injured, at least superficially, by the frequency of joints, of which there are at least two systems intersecting each other at a small angle, thus cutting the slates into rhomboidal masses, as they weather to pieces. . . . . Opposite the village of Little Falls a trap dyke of basic doleryte, apparently about 10 feet wide, appears in the slate, going diagonally across the slate; and on the south side of the dyke, in the lee of its protection against the current of the river, as well as against, possibly, the ice of the ice-period, the slate (or schist) is decomposed to the depth of four or five feet at least, making a greenish-blue clay, or incipient kaolin."

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*Sixth annual report of this survey, p. 50.

At Campbell's point, on the east shore of the Mississippi, about a half mile south of the middle of Little Falls village, and about a fifth of a mile south from the south end of Mill island, rock is exposed along a distance of five or six rods, rising eight or ten feet above the river. In describing this rock and its probable origin, professor Winchell states that it "consists, in general, of a hard, dark-colored dioryte, containing mainly amphibole in coarse crystals, and a little feldspar (labradorite?). The outward characters of this rock are the same as the concretionary lumps that exist in the slate already described. It is here simply in larger area and bulk. It is parted by joints that cause it to fall to pieces in slabs and cuboidal masses. This *may be* here in the form of a dyke, but its relation to the slate cannot be seen. The point which is formed by it is considerably higher than the bottomland on either side, but falls away somewhat on receding from the river, the rock itself becoming lost to view in the swampy bottoms, or involved with the drift of the river-bluffs. On long-weathered surfaces, under the action of the water, there is a ridged and furrowed form that shows the same direction and trend as the slatiness of the slate, i.e. N. 18 deg. E. [magnetic]. The ridges are about ¼ inch apart, and about ⅛ or ¼ inch high, separated by intervening furrows. This surface configuration is apparently due to the alternate arrangement of the mineral contents, and perhaps has its origin in a metamorphosed condition of the slate itself, or of the sedimentary rocks from which they both may have been derived. Thus this could not be of the nature of an igneous dyke, but a metamorphic variation due to the complex nature of the original sediments. This view is strengthened by the occurrence of a similar dioryte rock, in concretionary masses, in the slate itself, running in more or less regular layers or lines. This alternation of mineral contents does not pervade the whole of the rock exposed on 'the point'; but it is a conspicuous feature in some places. The ridges are composed of the lighter-colored minerals, and the furrows of the amphibole."

At Pike rapids, which are three and a half miles south of Little Falls and about a quarter of a mile south of the mouth of Swan river, numerous low outcrops of schist occur in the banks and channel of the Mississippi along a distance of about an eighth of a mile, from the head to the foot of these rapids, which descend four or five feet. The rock here is a mica schist, containing many large crystals of staurolite and often small garnets. No veins or masses of quartz were noticed. On the west shore, which is only six to ten feet high, its exposures are numerous, but rise only one to five feet above the water. It rises in the channel of the river above its bed of boulders and sometimes above the water at frequent intervals across its whole width, the most conspicuous of these ledges being an island eight or ten feet high near the east side of the river. Small and low outcrops are also seen in the east shore, which is a steep bank of glacial drift, till capped with gravel, about 40 feet high. This rock has a laminated structure, which corresponds in strike with the cleavage of the slate at Little Falls and on the Little Elk river. Therefore, it should not, probably, be regarded as representative of the original layers of sediment, from which this rock has been derived by metamorphism. This lamination or foliation in the outcrops along the west shore of the river at Pike rapids has a strike N. 20° E., with a dip 70° to 75° N. 70° W.*

At Cash's rapids, about two and a half miles below Pike rapids, schist nearly like the foregoing occurs in low outcrops in the channel and on the west shore, rising two or three feet above low water.

About a quarter of a mile below the last, and probably in the north edge of section 17, Bellevue, rock almost exactly the same as at Pike rapids is seen in the east shore of the river along a distance of about fifteen rods, rising at the highest place, near its south end, fifteen feet above low water. Its lamination has a strike N. 25° to 30° E., and dips about 45° N. 65° W. Some twenty-five or thirty rods farther south, it again has a small exposure in the east bank, and forms an island which rises about eight feet above low water, and extends eight or ten rods from northeast to southwest, situated about a third of the way across the river from its east side.

Half a mile farther south, at the middle of Muncy's rapids, which are a quarter of a mile long, mica schist, filled with many large staurolite crystals, and sometimes also including small garnets, as at Pike rapids, extends about twenty-five rods along the east shore of the Mississippi, rising some eight feet above low water. This is on land of Isaac P. Lambert, in the north part of the S.W. ¼ of section 17. Bellevue. Its strike, nearly the same as at the last place, is N. 25° to 30 ° E., and its dip is about 60° N. 65° W. It has been slightly quarried for cellar walls, etc., and lies in layers from three inches to one foot thick. This rock also juts up at many places in the adjoining channel of the river along a distance of fifty rods or more, rising two or three feet above low water.

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* The site of the fort or stockade in which Lieut. Z. M. Pike and his men spent the winter of 1805-6, from which the rapids received their name, has been found by Mr. Nathan Richardson, of Little Falls, at a point on the west side of the Mississippi about fifty rods below these rapids, on nearly level land some fifteen feet above the river, and not over sixty feet from its shore at low water. This stockade was about thirty-eight feet square. At its northwest corner is a large pile of stones, doubtless used for a fireplace. The first settlers, twenty-five years ago, saw two of the bottom logs still remaining.

About a half mile below the last, the same staurolitic mica schist outcrops at the west side of the river, having an extent of only a few rods. but rising steeply to a hight of fifteen feet or more above the river. This is on the land of Charles Gillpatrick, in the N. E. ¼ of the N. W. ¼ of section 32, Swan River. Its strike is N. 20° E., and its dip is about 70° N. 70° W. It contains occasional masses or bunches of white quartz; one noted being a foot in length. This is the most southerly exposure of the staurolitic schist, which thus has frequent outcrops for four miles along the Mississippi, at Pike rapids and southward. Its lithological characters are nearly uniform throughout this extent; and its lamination has a nearly constant strike and dip. Proceeding northward, we find this strike and dip continued in the cleavage of the slate at Little Falls and on the Little Elk river, but with a slight deviation of the strike to a more northeasterly course. Beyond these outcrops northeastward, the nearest exposure of similar rocks is the district of slate ledges at the Northern Pacific Junction and on the St. Louis river, a hundred miles to the east-northeast. There the cleavage strikes nearly due east.

The only remaining outcrops of these crystalline rocks beside the Mississippi in Morrison county are about a half mile south from the last, being at Blanchard's rapids, best exposed upon the west side of the river, on land of Allen Blanchard, in the S. E. ¼ of section 32, Swan River. Here ledges are seen at numerous places upon an area of twenty or twenty-five acres, but nowhere rising more than two to four feet above the general surface. The largest exposure beside the river is fully a hundred feet long and averages forty feet in width. This is uniformly a very hard, compact, dark dioryte. It has no staurolite crystals. It shows no lamination, but is very much divided by joints, which are from one or two inches to a foot apart and nearly vertical. Their two principal sets bear N. 75° W. and due N. Lumps of white quartz, up to six inches in diameter, occur in this rock; and a vein of it a foot wide was reported, but at the time of my observation was covered by high water. This rock reaches in occasional outcrops one or two feet above low water some three-fourths of the way across the river, which is here an eighth of a mile wide; but it has no exposures on the east shore. About ten rods west from the large outcrop beside the river, nearly the same rock, but much less divided by joints and somewhat finer-grained, is exposed upon a space about a hundred feet square, from which the covering of drift, with a thick growth of timber, was swept away about ten years ago by the sudden flood from a broken ice-gorge.

A stratum of rock, apparently belonging in the same group with the preceding, was encountered by the well of Mr. Calvin A. Tuttle, two and a half miles south from the last and close north of the mouth of the "main Two rivers." This well is about 23 feet above the Mississippi, which flows close at the east. Its depth of 50 feet was as follows: soil, 1½ feet; gravel, with pebbles up to six inches in diameter, 4 feet; "white stony clay," probably a marly till, 4½ feet; bluish till, 7 feet; apparently decomposed rock, of various colors and in irregular masses, with considerable kaolin in oblique layers, up to about six inches in thickness, 8 feet; and thence to the bottom, apparently a decomposed hydromica schist, dug into 25 feet and bored into 4 feet deeper. At the time of excavation, which was done with pick and shovel, this rock was thrown out in pieces up to ten pounds in weight; but all these, within a few weeks, by exposure to air and rain, were crumbled to a powder. It had no staurolite crystals, but occasional quartz lumps, from three to ten pounds in weight, and one of fifty pounds, were found in it.

On the Swan river. Swan river, in the southwest corner of section 1, of Swan River township, about one and a half miles above its mouth, as reported by Mr. Samuel Lee, has a fall of nine feet in six rods, over a bed of rock closely like that of Pike rapids, one and a half miles east. He thinks this has no exposure in the banks, of which that on the northeast is low, while that on the southwest is about 40 feet high, being composed of gravel and sand.

At the Ledoux bridge on Swan river, in the S. E. ¼ of the S. E. ¼ of section 4, Swan River township, a dark, compact rock, in part slaty and in part resembling quartzyte, is exposed in the bed of the stream and forms the foundation of the bridge abutments. Specimens were obtained; but observations of jointing, cleavage, or lamination, were prevented by the high stage of the water. Several exposures of this rock are reported in the channel of the river within a quarter of a mile above and below this bridge.

West of Little Falls. In the S. E. ¼ of the N. E. ¼ of section 13, T. 129, R. 30, about one and one half miles northwest of Little Falls, numerous outcrops of rock, rising one to five feet above the general surface, occur upon an area some thirty rods long from north-northwest to south-southeast, and ten to twenty rods wide. This rock is all massively crystalline, with no apparent lamination or cleavage. It is all quite dark, probably including much hornblende. In part it is fine-grained; but mostly it is about medium-grained, and in part is quite coarse. The last of these varieties is sometimes decayed and friable, but mainly this rock is very compact and hard, not readily splitting in any particular direction. No staurolite, garnet, nor pyrite crystals were observed. Nearly all the varieties of this rock, when long exposed to the weather, tend to exhibit crystals of a greenish mineral, a sixteenth to a fourth of an inch long; and by further weathering these are dissolved, leaving small cavities. Mica is rarely present; it was noted only in narrow veins, a half to one inch wide and of small extent. These ledges are on the east border of an area of till, which thence extends indefinitely westward. They are ten to fifteen feet above a grass-marsh, a half mile wide, which lies on the east and southeast, but are scarcely higher than the plain of modified drift which occupies the Mississippi valley eastward.

Near the fork of Little Elk river. The only other outcrops of the crystalline rocks known in Morrison county are in the N. E. ¼ of section 7, T. 130, R. 30, being between the north and south forks of the Little Elk river, about a quarter of a mile northwest of their junction. One of these ledges is crossed by the road some thirty rods west from the ford of the north fork. Thence the rock reaches about fifteen rods south, with a width of one to two rods; but northward its exposures extend fully an eighth of a mile, occurring frequently upon a width of five to ten rods. It is said to have no outcrops upon any of the streams of this vicinity. As this whole region is woods, other outcrops may have escaped notice. The rock here rises in ragged knolls and small north-to-south ridges, three to eight feet above the general surface, which is 10 to 25 feet above the north fork. It is nowhere massively crystalline, like the dioryte at "the point" near Little Falls; but is a dark schist, having always a more or less distinct lamination, often irregular and contorted. Its strike is uniformly from northeast to southwest, or within five degrees of this; and its dip varies from vertical to 75° N. W. It has no slaty cleavage, and is all very compact and hard, with few joints. In color and texture it is nearly like some portions of the Little Falls ledges. So far as examined, it has no staurolite nor garnet crystals. In one place a specimen was obtained, holding numerous large pyrite crystals, but these are not generally noticeable. This dark rock sometimes becomes by weathering spotted with brown particles; and by further weathering these are dissolved, leaving a minutely pitted surface. Often the rock includes gray, apparently quartzose, lenticular masses, a half to one inch thick and four to. twelve inches long, coinciding with the nearly vertical northeast-to-southwest lamination. It has been slightly quarried by Gilbert T. Smith for his mill, situated a half mile to the east.

STEARNS COUNTY.

Ashley. The most northwestern rock-outcrops of this county are found in Ashley township, eight miles west of Sauk Center. They lie close south and southwest of a school-house at the south side of Ashley creek, partly in the S. W. ¼ of the N. W. ¼ of section 17, owned by George H. Pendergast, and more in the S. E. ¼ of the N. E. ¼ of section 18, on land of Lucas Kells. This rock has numerous exposures, the largest being about a hundred feet long, upon an area which reaches thirty rods from east-southeast to west-northwest, their hight being from one to five feet above the general level. It resembles syenite, but contains much of a light-green mineral (probably epidote), like that mentioned in the ledges thirty and thirty-five miles farther north, in Todd and Cass counties. This takes the place of hornblende and mica, neither of which can be detected. Joints occur from one to five or ten feet apart. No schistose or laminated structure was observed. Vein-like masses of coarsely crystalline orthoclase, enclosing small amounts of white quartz and of the green mineral, occur in this rock at many places, often extending ten feet or more, and varying from one to several feet in width. These ledges may be quarried for coarse masonry. Their surface is smoothed by glacial erosion, but retains no striæ.

Sauk Center. Exposures of rock are found at the southwest side of the railroad from an eighth to a fourth of a mile southeast from Sauk Center depot. They are partly upon the land of the railroad, but mostly for their western portion upon land owned by Tobias

Carl. The largest outcrop is about fifty rods from the depot, and a hundred feet southwest of the railroad, covering an area about six rods long from northwest to southeast by two to three rods wide, and rising only one to two and a half feet above the general surface. This ledge has several distinct varieties of rock. The greater part is a reddish feldspathic gneiss, laminated from northeast to southwest, or a similar syenite where this lamination is absent. Masses a few feet in extent, not definitely separated from the foregoing, are very coarsely crystalline, flesh-colored feldspar and quartz ; the latter constitutes about one-fourth part; and both occur in crystalline masses one to two inches long. Portions of this gneiss and syenite are porphyritic with feldspar crystals up to a half inch, or rarely an inch, in diameter.

The most southern part of this ledge, extending thirty feet from east to west, and ten feet wide, divided from the last by a width of about two rods which is covered with drift, is a very hard and compact, dark, granular rock, perhaps to be called syenite, in which the most abundant mineral is apparently hornblende. A small space of this, about eight feet long and four feet wide, shows a vertically laminated structure, curving from a south to a southeast course.*

Eight rods west from the last is another exposure of the same hard, dark rock, about two rods in extent, not rising above the general level. About fifteen rods west-northwest from the large outcrop first described, another of similar rock is found, being mainly gneiss, laminated from northeast to southwest. This ledge is about fifty feet long from west-northwest to east-southeast, and rises from one to one and a half feet above the general surface. Again, some twenty-five rods southeast from the first described exposure, excavations at each side of the railroad, five to fifteen feet below the track, show the dark, tough hornblendic rock, like its two exposures farther west, except that here it is more intersected by joints, which are from one to six feet apart. On the southwest side of the railroad this rock is uncovered for a length of a hundred feet; but on the northeast side only two or three small knobs are visible. None of the outcrops are suitable for quarrying.

Melrose. The next exposure of the bed-rock is eight miles east-southeast from the last, at Clark's mill, in Melrose. This mill, situated on the south side of Sauk river about ten rods west of the bridge, is founded on a ledge of very hard, coarse, red syenite, which also extends some twenty-five feet from the mill, half-way across the waste-way of the dam.

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* Glacial striæ, clearly seen on the west part of this southern outcrop, bear S. 40° E., being at right angles with the striæ noted in Sauk Rapids, about forty miles farther east.

In the west part of Melrose village, a third or half of a mile west from this mill, and on the level plain of valley drift, rock has been encountered in attempts to dig wells at W. H. Rothaermel's house. Its depth below the surface is about six feet, and it has an extent of a hundred feet or more. A well blasted into this rock supplied the stone for the foundation of the Methodist church near by. It is a dark, unlaminated, rather coarsely crystalline, hornblendic rock, different from any other found in this district.

Wakefield. Several outcrops of very hard, dark dioryte, and of coarse syenite occur within a radius of a fourth of a mile about the corner of sections 19, 20, 29 and 30, Wakefield. This is on the north side of the Sauk river, two miles east of Richmond, and about twenty miles southeast from Melrose. One of these knobs rises forty feet above the general level. The abutments of the Richmond bridge were quarried at this locality.

About one and a half miles farther east, near the center of section 21, a small outcrop of coarse syenite occurs in and close south of the road, its length being four rods and its hight three or four feet. It is intersected by joints at intervals of two to six feet.

At Cold Spring, one and three-fourths miles farther east, a fine-grained, reddish, much jointed syenite has abundant outcrops, underlying the mill and dam, and covering an area on both sides of the Sauk river equal to a quarter of a mile square, with its highest points 20 to 25 feet above the river. It has been somewhat quarried for local use in foundations, walls, etc.

Rockville. Four miles farther east, massive outcrops of coarse-grained, gray granite, containing black mica, which weathers to yellow, occur near Rockville. The most prominent mass of this rock is at the east side of Mill creek, a quarter of a mile south of Rockville mill, forming a knob forty or fifty rods in length and breadth and fifty feet high. This rock is very free from joints or seams, being sometimes unbroken for thirty or forty feet. Otherwise it appears to be well adapted for quarrying, to supply stone for heavy masonry, as bridge piers and abutments. Two other exposures of this rock are found a quarter of a mile northeast from this mill. The most southerly of these, situated east of the road, covers some thirty rods square, and rises about forty feet above the river; and the second, less than an eighth of a mile farther north, crossed by the road, and lying mostly between the road and the river, covers an area 30 by 20 rods in extent, and rises 20 to 30 feet above the river. Both consist of massive, rounded ledges, with few seams or joints, which are often twenty to thirty feet apart.*

Saint Joseph. In the N. E. ¼ of section 26 of this township, nearly four miles northeast from Rockville, massive, coarse-grained, gray syenite or granite, closely like that of Rockville, is exposed on the land of Fred Schilplin, about an eighth of a mile southeast from his house. It forms a rounded outcrop some twenty rods broad, rising ten feet above the general level, its hight above the Sauk river, three-fourths of a mile to the northwest, being about 35 feet. This ledge has few joints, one space fifty feet square being without a seam.

One and a half miles west-southwest from the last, an exposure of rock is reported in section 27, on land of I. S. Staples, at the east side of Sauk river, above which it is said to rise five to ten feet, covering an acre or more.

Saint Augusta. Granite, containing flesh-colored feldspar and black mica, is exposed near the middle of section 19, Saint Augusta, about a fourth of a mile west of Luxemburg post-office and St. Wendel's church. This is four miles east-southeast from Rockville and eight miles south-southwest from Saint Cloud. It lies on the west side of a slough, above which it rises 15 to 20 feet, its extent being about twenty rods. It is divided by joints three to fifteen feet apart; the course of their principal system, nearly vertical, is from northwest to southeast.

Saint Cloud. This township has many exposures of these rocks, principally syenite.

In the N. E. ¼ of section 32 a reddish gray syenite or granite, and in the N. W. ¼ of section 33 a very dark syenite, containing a large proportion of hornblende, form quite extensive outcrops, in each case covering an area equal to a quarter of a mile square. An eighth of a mile west of the road, these rounded hillocks of rock rise 20 to 25 feet above the general level; and close east of the road and for an eighth of a mile or more from it, their hight is five to ten feet. About forty rods farther north, the road goes by ledges of syenite nearly like that of the quarry at Sauk Rapids. These are probably in the southeast corner of section 29; they lie close west of the road, above which they rise 15 to 20 feet. The next two miles to the north and northwest have abundant outcrops of gray and reddish syenite, of which the following is a list in part.

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*These and nearly all the ledges of eastern Stearns county are planed and worn to a smooth surface by the ice-sheet; but none of them, so far as seen in this survey, retain glacial striæ, because of the slight disintegration wrought upon their surface by rains and frosts.

On land of Jacob Streitz, in the N.W. ¼ of the N. E. ¼ of section 28, considerable quarrying has been done, forty cords or more of the stone having been sold for masonry in Saint Paul. This is an excellent gray syenite, rising about ten feet above the general surface, well adapted for supplying dimension stone. It is near the eastern side of this tract of abundant ledges; and the hills one to one and a half miles east and northeast, rising 50 to 75 feet higher and 125 to 150 feet above the Mississippi river, are morainic drift.

A quarter of a mile west of the last, on land of Louis Hohmann, in the N. ½ of the N. W. ¼ of section 28, ledges of the same rock as the last cover two or three acres, rising about five feet above the general level of the surrounding modified drift. Some quarrying has also been done here.

On land of Ferdinand Hartmann, in the north edge of the N. E. ¼ of section 29, he has quarried during several years, in two low outcrops of syenite, selling the stone for $3 per cord at Saint Cloud. The southwestern outcrop, six rods square, is a somewhat coarse-grained, reddish syenite, divided by joints from one to eight feet apart. The other ledge, fifteen rods north-northeast from the last, is about ten rods long from west to east by six rods wide. This is mainly red syenite like the former, but includes a large mass, occupying an area about four rods square, of finer-grained, bright gray syenite, containing occasional scales of black mica. At its border a gradual change of color takes place from the gray to the red.

An area of several acres of reddish syenite, like that of the last localities, begins thirty or forty rods northwesterly from the last, and reaches a sixth of a mile or more northward. This is on land of Matthias Leim, in the S. ½ of the S.W. ¼ of section 20, and of Nicholas Scheuer in the north half of the same quarter-section. It rises in rounded hills and knolls 30 to 50 feet above the lowland eastward.

About forty rods northwest from the last, in the N. W. ¼ of the S. W. ¼ of this section 20, owned by Nicholas Scheuer, gray syenite, closely like that of Streitz and Hohmann, and of Hartmann's northern quarry, forms a hill which covers six or eight acres and rises 50 feet above the general surface. It is smoothly glaciated, but retains no clear striæ. This rock has few joints, sometimes none for an extent of thirty feet. Here and upon many of the ledges of this region a scale of rock a fourth to a half of an inch thick, has become separated or is easily separable from the surface by weathering. In some places this might be attributed to forest or prairie fires, which seem often to have produced such scaling; but here it is notably exhibited on bare ledges six rods or more in extent.

Within a mile westerly are many lower outcrops of this syenite, rising 10 to 20 feet above the average of the vicinity. Good locations for quarrying are reported on the land of William B-sinius, in the S. E. ¼ of section 19, and of Jacob Hiltimes in the west half of this section.

The red syenite continues from the ledges owned by Hartmann and Leim northerly to the land of the Saint Cloud Granite Manufacturing Co., L. A. Evans, agent. This is the N. W. ¼ of the S. W. ¼ of section 17, where excellent quarrying stone is found. A few years ago a block of this red syenite was obtained for a monument pedestal, which had been sought but could not be supplied (so reported) from the famous quarries of similar stone at Aberdeen, Scotland. The size of this block was 7 feet square by 2½ feet high, its weight being ten tons. It was cut and polished in Saint Cloud, and was sold in Chicago for about $800. This quarry has not been worked for the past two or three years.

Excellent localities for quarrying the same red syenite also occur within a half mile west and southwest from the last, in the S. E. ¼ of section 18, owned by H. C. Waite, and in the N. W. ¼ of section 19. Some of these localities also yield gray syenite, and that which is gray, tinted reddish.

Syenite outcrops in the N. W. ¼ of section 17, at the northwest side of the road about a half mile west of John Becker's. Its extent is about fifteen by ten rods, and its hight is some twenty feet above the adjoining lowland and river, an eighth of a mile west, and eight feet above the road. This ledge exhibits some marks of water-wearing. A system of nearly vertical joints crosses it from north to south, varying from six inches to four feet apart; and others, less conspicuous and less numerous, extend from east to west.

The only exposure of rock beside the Mississippi river in this county below the Saint Cloud bridge, is about a half mile south of the state normal school, at C. Bridgeman's steam saw-mill and for twenty rods to the south. It is coarse gray syenite, with joints ten to twenty feet apart, and forms small ledges five to ten feet above the river.

Fifteen to twenty rods south from the west end of the Sauk Rapids bridge, is a ledge of porphyritic, gray-syenite, consisting mostly of feldspar, with about a fourth part of quartz, and including some hornblende and rare grains of mica. It rises some five feet above the river, and is traversed by nearly vertical joints one to eight feet apart. It has been slightly quarried.

Le Sauk. In this township, situated next north of Saint Cloud, these crystalline rocks are exposed upon the lowest mile of Watab river, and at several places within three miles thence north-northwest. The grist-mill and its dam, owned by J. B. Sartell & Sons, on the Watab river, about a third of a mile above its mouth, are founded on gray syenite. This is exposed to view only on the south side of the river, under the foundation of the north side of the mill, rising a few feet above the water of the flume below the dam. It was quarried for this mill, and is a desirable building stone.

Mr. Sartell owns another quarry a half mile northwest from this mill, covering several acres and rising twenty feet above the general level. It is in or near the S.E. ¼ of section 17. This has a more reddish tint. Quarrying has been done here more or less during the past ten years, perhaps yielding quarried stone to the value of $1000 in all, only for use in this vicinity.

A third of a mile east of the last, in the south part of section 16, is another outcrop of rock, similar to that at the grist mill. This covers about two acres. It has a low smoothed surface, not much above the general level.

Another ledge of similar syenite or granite is seen at the west side of the road, east of the north part of Clark lake, in the south half of section 8. This also covers two acres or more, its hight being about ten feet.

On or near the east line of section 9, a rock-outcrop, said to be coarse-grained and of iron-rusty color, covers several acres and rises some fifty feet above the Mississippi river, which is ten or twenty rods farther east.

Reddish fine-grained syenite has been somewhat quarried for local use, in or near the N. E. ¼ of the N. E. ¼ of section 7, on land of D. B. Searle. Farther northwest, near the center of section 6, similar rock has outcrops at many places along a distance of about half a mile from east to west, not extending into Saint Wendel township.

Brockway. A medium-grained, gray granite or syenite, containing garnets a fourth of an inch in diameter, is exposed on the N. W. ¼ of section 33, in the southeast part of Brockway, on land of William Gordon, about a quarter of a mile west from the road and from his house. It shows only a smooth flat surface, ten by fifteen feet in extent, not rising above the general level.

Rock is also reported to occur in the west shore of the Mississippi river, about fifteen rods south from the northeast corner of this section 33. The rock is exposed also in the east bank and in the channel of the river, but its outcrops rise only two or three feet above extreme low water. This is about a mile north of the high hills of rock at the east side of the river in Watab.

SHERBURNE COUNTY.

The principal quarries of the district here reported are near Saint Cloud, but are situated on the opposite side of the Mississippi, in Sherburne and Benton counties. In their order from south to north, these quarries are in Haven, the northwest township of Sherburne county, and in Sauk Rapids and Watab, the townships which succeed next to the north, lying in Benton county, all bounded by the Mississippi river on the west.

Haven. The most southern rock-outcrop is in the S. ½ of the S. W. ¼ of section 17, four miles southeast of Saint Cloud, and about two-thirds of a mile west of the Saint Paul, Minneapolis & Manitoba railway. It is owned by Robbers & Barthelemy, and was by them leased in May, 1881, for two years, with privilege to extend the lease three years more, to the firm of Saulpaugh & Co., of Rock Island, Illinois, who are contractors for building the bridge for the Northern Pacific railroad across the Missouri river at Bismarck. They have also leased quarries in Watab for this bridge, which in its abutments and four piers requires 7000 cubic yards of cut stone. The outcrop has an area of four or five acres, being about thirty rods across, and rises with a rounded, smooth surface of bare rock ten to fifteen feet above the surrounding prairie of nearly level modified drift. Hence it is often called the "rocky island" or "rocky point." About ten rods west of the main outcrop is another of small extent.

This rock is a coarse-grained syenite, of whitish gray color, with dark blotches of hornblende. It is evidently a stone of great strength and durability. The first quarrying at this point was by Daniel Burns, of Sauk Rapids, in 1879, supplying stone, some 600 cubic yards, at price of about $9,000, for the Mississippi river bridge of the Chicago, Milwaukee & Saint Paul railway on the short line between Saint Paul and Minneapolis.*

Two miles north from the foregoing and the same distance southeast from Saint Cloud, are the quarries of Breen & Young, situated close west of the railroad, nearly on the line between the S. E. ¼ of section 6, and the N. E. ¼ of section 7, Haven. The rock here has frequent exposures along a distance of nearly a half mile from the quarry, to the southeast and northwest, rising five to twenty feet above the adjoining marshy lowland. On the south and southwest side it is covered by morainic drift, which forms a ridge 40 to 50 feet high and of irregular contour, reaching from the railroad westward through section 7. Most of these ledges are a gray syenite of fine grain and uniform texture, well suited for building purposes. It is used in the corners, steps and trimmings of the United States custom house and post office, in Saint Paul. Breen & Young employ about twenty-five men here in quarrying. The greater part of their stone-cutting, especially for ornamental work, is done in their shops at Saint Paul. Their quarry of this syenite, commonly called granite, has been wrought since 1868; the extent of the principal excavation is about 250 by 200 feet, and its depth is mostly from four to six feet. About thirty rods west of this opening is an area of reddish syenite, which has been slightly quarried. The same color is also seen in small outcrops a sixth of a mile farther north beside the railroad.

In Haven and generally through Benton and Stearns counties, this belt of crystalline rocks consists mainly of syenite, which differs from true granite in containing the mineral hornblende instead of mica, both being otherwise alike composed of quartz and feldspar. The three ingredients of each occur in crystalline grains; and no schistose or laminated structure, and consequently neither dip nor strike, are observable. The common species of feldspar present in these granites, syenites, gneisses and schists, is orthoclase.

NOTE. These are the only exposures of rock in place in Sherburne county. Principally the surface of this county is the stratified sand and gravel of the modified drift, bearing a thin forest growth in which black and bur oaks are the most abundant species. Comparatively small areas or belts are composed of till, or intermixed clay, sand, gravel and boulders, unstratified. The boulders are mostly syenites, granites and crystalline schists, with occasional pieces of limestone In size they are mostly less than five feet in diameter, and boulders more than ten feet in diameter are very rare in nearly all parts of

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*No boulders are seen on the surface of this ledge; and though it is wholly moutonned, or smoothly planed and rounded by glacial erosion, no distinct striæ were found.

Minnesota. One of the largest found in this state is the "big rock," situated on land of Peter E. Clarity, in the N. W. ¼ of the S. W ¼ of section 7, Palmer, six miles east from Breen & Young's quarry. The dimension of this mass is about 20 by 35 feet, and its hight is 20 or 25 feet It probably also reaches several feet below the surface, from which it rises perpendicularly on all sides. This boulder is dark mica schist, varying to gneiss. coarsely laminated, with much black mica and many minute garnets, and containing in some portions whitish feldspathic layers from a quarter of an inch to two or three inches in thickness From it numerous fragments, three to ten or twelve feet long have been riven off by frost, especially on its northwest side. It lies on a southwes erly sloping swell of till which forms part of a morainic belt, 20 to 50 feet above the general level, extending from section 9, Palmer, west to section 7, Haven.

BENTON COUNTY.*

Sauk Rapids. This township has many outcrops of rock. The quarry which has been longest worked and yields the best stone, a fine-grained gray syenite, especially adapted for ornamental use and for cemetery monuments, is situated nearly in the center of the village of Sauk Rapids. It was first opened by Mr. F. A. Fogg, in May, 1867, and was worked by him four years. It is now owned by Collins, Mitchell & Searle, of Saint Cloud, and within the past three years has been leased and worked by Messrs. Burns, Reeder and Robinson, who cut and polish the stone near the quarry. The excavation is about 150 by 100 feet in extent, and five to seven feet deep. The sales are about $2,000 annually, and have varied from $500 to $10,000 a year. In Minneapolis the towers of the suspension bridge and the city hall are trimmed from this quarry, the rest being Trenton limestone. In Saint Paul the wholesale hardware store of Nicols & Dean is built from this quarry, except the columns and buttresses, which are from Watab. In Milwaukee this quarry supplied the polished front of the Mitchell Bank building, some of the slabs used being 11 feet by 3 by 1 foot in dimension. The Iowa state capitol at Des Moines, recently built, took part of its stone for trimmings from here, some of the pieces measuring 10 by 2½ by 2 feet. This syenite is closely like that of Breen & Young's quarry in Haven.

A coarser syenite is exposed about a quarter of a mile farther west, at the east end of the Sauk Rapids bridge and dam, which are founded in part upon this rock. Its outcrop, coarsely porphyritic, a few rods south of the west end of this bridge, is described on a preceding page, with the other rock exposures of Saint Cloud, Stearns county.

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* The drift in this county is generally till, having a moderately undulating or rolling contour, with no conspicuous elevations, but rising in gentle swells 40 to 60 feet above the streams It is mainly covered with heavy timber, all of deciduous species, excepting in the north and east portions of Alberta, which have a good growth of white pine. Upon the greater part of the county the bed-rocks are wholly covered by the drift.

The fall in the Mississippi here in about one mile, from the mouth of the Sauk river to Maple island, is 22 feet, from 992 to 970 feet above the sea. Its channel is strown with boulders, but has no extensive exposures of solid rock.

About a mile east from Sauk Rapids, in the N. W. ¼ of section 24 of this township, an outcrop of reddish, rather fine-grained syenite occurs in a swampy depression, some twenty-five rods south of the Gilmanton road. Its area reaches about twenty rods from north to south and is about ten rods wide, with a hight of two to five feet. This rock is traversed by joints from one to ten or fifteen feet apart. Its surface is smoothly glaciated but retains no striæ.

An exposure of gray syenite occurs in the S. W. ¼ of section 13 of this township, on land of Robert W. Leyerly. Its extent is about 50 by 30 feet, with hight of three feet above the adjoining marshes. It is crossed by joints two to eight feet apart.

In the N. W. ¼ of section 13, on land of the E. D. Learned estate a coarse-grained reddish syenite, with large proportion of feldspar, covers an area thirty rods or more in length toward the west-northwest, averaging eight rods in width. Its higher portions are four to seven feet above the marsh which mainly surrounds it. This rock is very massive, extending in some places thirty to forty feet without a joint. It is cut by a trap dike, the ordinary dark and tough doleryte, one to one and a half feet wide, and reaching within view about fifty feet from east to west.

Extensive outcrops, partly of coarse-grained reddish syenite, and partly of finer-grained gray syenite, of which the latter has been considerably quarried, occur on the N. E. ¼ of section 14, on land of Joseph Moody; covering some thirty acres and rising 25 feet above the adjoining swamps, or 75 to 100 feet above the Mississippi. This rock is mostly divided by joints from six inches to five feet apart.*

Syenite nearly like the coarse reddish portion of the last or that described in the N. W. ¼ of section 13, occurs also at several places in the S. E. ¼ of section 11, on land of William Kouts. Its most northerly exposures are about sixty rods north of the south line of the section, and do not rise above the general level of the surrounding marshy land. A smooth surface of this rock, about fifty feet across, being the largest patch seen here, has no joint or seam. An outcrop of this rock about a hundred feet square, lying some forty rods south-southwest from this, upon the same quarter-section and three to ten rods north of its south line, rises five feet above the general level and is divided by joints three to eight feet apart, mostly running north and south, with others less numerous from east to west.

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* In several places on this quarter-section distinct glacial striæ were observed, bearing S. 45° to 50° W., by the true meridian. At another point, a few rods from these, their course is S. 15° W. On the other ledges of this township before described, these marks have been effaced by weathering.

In the N. E. ¼ of the N. W. ¼ of section 11, owned by Collins, Mitchell & Searle, and in the adjoining N. ½ of the N. E. ¼ of the same section, owned by E. E. Beal, are large exposures of red syenite, which has been quarried somewhat. It covers about ten acres, and rises ten to twenty feet above neighboring depressions. At the quarry it is distinctly red near the surface, but gradually changes to gray at a depth of three or four feet. It is rather coarse in grain. Feldspar, quartz and hornblende are all present in considerable amount, the feldspar being about half of the whole. This rock is very massive, sometimes extending a hundred feet without a joint. The distance to the railroad is one and a half miles, and to Sauk Rapids, two and a half miles.*

Watab. The southern two miles of this township, to a distance of three miles from the Mississippi, have many outcrops of these crystalline rocks, mainly of syenite, which presents varieties similar to those described in Sauk Rapids.

In the N. W. ¼ of section 35, about one-third of a mile east of Watab station, is the quarry of Talcott, Castle & Co., which was worked by them in 1871 with forty men, drawing the stone six miles to Sauk Rapids, then the end of the railroad. This stone was mostly used for buildings in Chicago, which were destroyed in the great fire of October, 1871. It has been much used for cemetery work, as monuments and bases.†

About a half mile farther east, in the N. E. ¼ of this section 35, is the quarry owned by H. D. Gurney, of Saint Paul, which was opened and considerably worked in 1874 and 1875. From that time it remained idle till 1881, when it was leased to Saulpaugh & Co., by whom it was operated with from fifty to a hundred men, including quarrymen and cutters, the stone being used with that quarried by them in Haven, as before stated, for the Northern Pacific bridge at Bismarck. This exposure includes three distinct varieties of syenite: gray, coarse-grained, which makes up the greater part of the stone quarried; gray, finer-grained; and reddish, with grains of intermediate size. These kinds of rock lie in contact, showing, at least in some portions of the quarry, no gradual transition but an abrupt change at a definite line. A branch track, a mile in length, was laid from the railroad to this quarry in May, 1881.

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* Glacial striæ, seen at a dozen places upon this outcrop, bear quite uniformly S. 50° W., referred to the true meridian, varying rarely to S 45° W. and S. 55° W.

† Glacial striæ were observed here, bearing S. 15° W.

Extensive ledges of similar rock lie in the S. E. ¼ of section 36.

In the north part of section 34, on land of Joseph Campbell, are also large exposures of syenite of excellent quality, but not yet quarried, except to supply a block, 3 by 1½ by 1 foot in size, polished on one side, which was sent to the Centennial Exposition.

The highest points of the foregoing ledges rise 10 to 20 feet above the average of the adjoining land, or 75 to 100 feet above the Mississippi river, which here is 1,000 feet above the ocean.

Prominent knobs of syenite, mostly reddish and somewhat porphyritic, and often darker and finer-grained than the preceding, sometimes in appearance approaching trap, dikes of which are also present, occur in section 27, between the railroad and the river, a half to one mile north from Watab station. At each side of the river road its elevations are 40 feet above the road and 75 to 90 feet above the river. One of these hills of rough, bald rock (called by Schoolcraft the *Peace rock*) rises in moderate slopes directly from the river's edge about a half mile south from the mouth of Little Rock creek, which was so named because of these ledges.

Prospecting for gold was undertaken here, some fifteen years ago, by Major T. N. Newson, sinking a shaft about ten feet. This is close southeast of the river road, near the center of section 27. It is some 40 feet above the river, with a depression on the east, separating it from a hill about 75 feet high a sixth of a mile east. The vein explored is quartz, one to eight inches thick, dipping 80° S. E. The east wall of this vein is dark and tough trap; and its west wall is a porphyritic, reddish syenite.

A small outcrop, twenty-five or thirty feet across and some 15 feet high, lies in the N. W. ¼ of section 26, a short distance east from the railroad and highway. Beyond this northward the only other rock-exposure known in this county near the Mississippi river is a small and low outcrop in its bank, of a tough, close-grained, hornblendic rock, occurring about a mile farther north, opposite to the northeast corner of section 33, Brockway, Stearns county.

Gilmanton. The only ledges that remain to be described in

Benton county are in its central and northeastern portions, within Gilmanton and Alberta townships.

In the S. E. ¼ of the S. W. ¼ of section 18, Gilmanton, on land of Clement Teller, about twelve rods west of the road, reddish syenite, mostly in large fractured blocks, is exposed at the south side of a small brook, upon an area two or three rods in extent.

About three-fourths of a mile west from this, similar rock is said to outcrop on the east side of the Elk river and in its channel, rising about ten feet above the river and extending six or eight rods.

Alberta. At the end of the portion of the old state road which had its timber cleared off, this being at the middle of the north side of section 20, in the east township of Alberta, the most northeastern of the county, this road crosses an exposure of rock which has an extent of about twenty-five rods from north to south, and is some fifteen rods wide. The quarter-section stake is about five rods east from the north part of this ledge, which extends into the edge of section 17, but lies mainly in the N.E. ¼ of the N.W. ¼ of section 20, on land of Charles A. Gilman, of Saint Cloud. The northeast part of this outcrop contains a dike of trap, dark with whitish spots, seen along a distance of thirty or forty feet and varying from eight to eighteen inches in width. Its course in the east part of its visible extent is S. 60° W.; but it is changed beyond to about due west. South of this dike the rock is a coarse-grained, reddish syenite, composed mostly of feldspar, with perhaps one-fourth part quartz. On the north side of the dike the texture of the rock is very different, though its mineral composition may be nearly the same. Here it is very fine-grained, and is much more traversed by joints, which are usually only one to two feet apart, dividing the rock into rhomboidal masses. These diverse rocks, definitely divided at this dike, appear to form respectively the south and north parts of this outcrop. Other ledges of syenite are reported within a mile northward, in section 17 and the N. E. ¼ of section 18.

About four miles east from the last, in the N.W. ¼ of section 24 of the same township, several exposures of coarse-grained reddish syenite occur in the banks and bed of the West branch of Rum river. In proceeding eastward and down the stream, the first of these outcrops is about twenty-five rods above the new "roll dam," which was rebuilt in 1879. At this upper ledge wings of logs are built on each side to turn the floating logs into the middle of the stream, which here falls three feet, the open space between the wings being thirty feet. The channel here and both banks to a hight one or two feet above the water, along a distance of twenty or thirty feet at each side, are this syenite, but it has no exposures upon the general surface, which is elevated only about five feet above the stream. The crystals of this rock are an eighth to a half of an inch long; about two-thirds of the whole consist of flesh-colored feldspar; about one-sixth is quartz, varying from whitish to smoky and transparent; and the remainder consists of dark particles, mostly hornblende, with rare grains of black mica.

At the "roll dam," twenty-five rods northeast from the last, the same rock is exposed in the south or right bank, and the south half of the dam for about seventy-five feet is founded on it. Its width visible is from ten to twenty-five feet, and its hight above the water below the dam is one to two feet. The fall here is also about three feet. Both these outcrops are massive, often showing no joint for twenty or thirty feet.

At a bend in the river about thirty rods below, being northeast and within sight from the "roll dam," the northern or left bank has an exposure of this coarse syenite, about twenty-five feet long and five to fifteen feet wide, rising one foot above the water; succeeded in the next twenty-five feet east by a very fine-grained, compact, but considerably jointed rock, of deep dull red color, apparently made up mainly of feldspar. Its extent seen was about twenty-five feet long by five to ten feet wide, reaching one foot above the water, which at the time of this examination was probably two feet above its lowest stage.

Within sight from the last and about a dozen rods down the stream, which here flows to the southeast, the coarse-grained massive syenite is again exposed in the northeast or left bank of the river. Its extent is about 50 by 10 to 20 feet, and its hight was two feet above the river, to which this ledge descends perpendicularly, with deep water at its side.

These are the first ledges found by lumbermen in descending this West branch of Rum river.

MILLE LACS COUNTY.

The only remaining exposures of rock on this stream are within three miles southeast from those last described, being in sections 19 and 29, of T. 38. R. 27, in Mille Lacs county.

T. 38, R. 27. At Stony Brook dam, situated on the West branch near the center of section 19, fifteen and a half miles in a straight line northwest from Princeton, and about three-fourths of a mile east-southeast from Brown's lumber camp and the mouth of Stony brook, the excavation at the north end of the dam shows a small exposure, about twenty-five feet across, of the same coarse, reddish syenite as occurs at and near the "roll dam." This has a smooth surface, nearly free from joints. Its hight is only one or two feet above the river.

In section 29, this rock occurs at many places in the banks and channel of the river along a distance of more than a half mile. These ledges begin about a mile southeast from the Stony Brook dam. The following notes describe them in the order that they were found in following down the river.

The first outcrop noted, perhaps below some which were not seen by me, occurs on the west or right side of the stream; and is about fifty feet square, reaching from the bank nearly across the river, which through this section varies from two to four rods in width, and is from three to six feet deep. It here has a fall of one foot, and the rock rises one to two feet above it. This is a massive syenite, coarse-grained and reddish, indistinguishable from that at the "roll dam."

At about twenty-five rods and again at thirty-five rods from the preceding, down the stream, which here flows south, ledges of the same rock are exposed in the left bank of the river, at each place having a length of about twenty-five feet and a hight of three or four feet.

Some twenty rods south from the last, where the river turns east, its right bank just below the bend has an outcrop of the same rock, extending four rods and rising five or six feet above the water. A part of this ledge is divided by east-to-west joints, one to two or three feet apart; but the higher southern part, like most of these outcrops, is massive, rarely intersected by joints.

About forty rods below the last, southeasterly, the river flows, falling about one and a half feet, over ledges of the same rock, in part divided by east-to-west joints. In the east or left bank these outcrops rise six feet above the water. Low exposures of this rock continue in the left bank about eight rods south, and after an interval of four or five rods again appear in the left bank for about fifty feet, rising seven feet above the river.

Twenty rods down stream, south-southwest from the last, ledges of the same rock re-appear in the left bank, and reach ten or twelve rods west-southwest, down the stream, rising five to eight feet above it.

Some ten rods below, westerly from the last, it is again exposed in the left bank at a small island.

From twenty to forty rods farther down the stream, westerly to where it turns south, then flowing south and southeast, there are frequent outcrops of the same rock at each side of the stream, above which these ledges rise from one to five feet. No exposures of rock are known below this on the West branch of Rum river; and none were found elsewhere in this region, except as described in the banks and channel of this stream. The descent of the West branch in its course of about three and a half miles from the "roll dam" to the lowest of these ledges, is estimated to be about 25 feet.*

The numerous rock exposures seen along these three miles are remarkably alike in lithological character, being a coarse, flesh-colored or reddish syenite, with occasional particles of mica. It is well adapted to be quarried for ordinary masonry and building purposes; but it has not yet been worked because settlements have not extended into this district.

On the main Rum river, generally denominated the "East branch," the drift and topographic features are mainly like those described on the West branch. Its only exposures of the bed-rock are about thirty miles, in a direct line, north of Princeton, being six to ten miles south of Mille Lacs. Low outcrops of small area, seen in descending this stream at Rum river falls, in the S. E. ¼ of section 18, T. 41, R. 26, a half mile above the mouth of Bradbury brook, and at other points a few miles below these falls, are described by Norwood as syenite, hornblende rock, gneiss, granite, and greenstone. Another outcrop is reported at the "ledge dam", on the south fork of the Bradbury brook, three or four miles above its junction with the East branch.

KANABEC COUNTY.

The glacial drift and surface features of this county are much like those of Benton and Mille Lacs counties. The ledges of crystalline rocks examined in Kanabec county are on Ann river in the vicinity of the Ann Lake dam; and on Snake river at and near its Upper and Lower falls, which are situated in T. 42, R. 23, respectively one and a half and two and a half miles south from the north line of the county.

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* The adjoining land is moderately undulating till, varying from a few feet to thirty or forty feet above the river, well wooded, but with little pine. Its soil promises well for agriculture. The pineries which still remain upon the head-waters of the West branch begin several miles farther northwest, beyond the west line of Mille Lacs county.

The Ann Lake dam, having eight feet head, and raising the level of Ann lake about five feet as a reservoir for log-driving, is situated two miles below the mouth of this lake in the east edge of the S.E. ¼ of section 30, T. 40, R. 24. About ten rods south from the gate of this dam is a rock exposure six or eight rods in length and width; but the rock does not appear here in the channel or bank of the river. Its next outcrop is some fifty rods down stream, southeast, being in the S.W. ¼ of section 29, at the southwest end of the "roll dam," extending ten or twelve rods beside the river, and about six rods in width. These outcrops rise five to ten feet above the river. Again, about thirty rods down stream, south from the last, and in the same quarter-section, or in the north edge of section 32, at a "breakwater," a ledge two or three rods in extent is found a few rods southwest from the stream, and six or eight feet above it, but not rising above the general surface. All these outcrops are on the southwest side of the river. They are all alike, being a light gray, rather fine-grained granite, somewhat decomposed next to the surface, so that it breaks with a crumbling fracture. In excavation by quarrying it would probably be found adapted for building purposes, with fair durability. Throughout these exposures it has a very uniform texture, with no noteworthy variation and no included veins. It is cut by joints from two to ten or fifteen feet apart.

Similar rock-outcrops are reported on the Little Ann river two to four miles west and northwest from the foregoing, in section 26, T. 40, R. 25, and probably in the S.E. ¼ of section 14, occurring at several places in the channel and banks of the stream; but not at its dam, which is in or near the S.W. ¼ of section 11.

Vicinity of the Upper and Lower falls of Snake river. The trip to these falls was from Kettle River station southwesterly by the north side of Pine lakes to McClure's lumber camp, situated on the west side of Cowan's brook, in the N.W. ¼ of the N.W. ¼ of section 35, T. 43, R. 23. The logging-road which follows down Cowan's brook, at about two-thirds of a mile south from this camp, in the S.E. ¼ of section 34 of this township, a little north of the line between Aitkin and Kanabec counties, goes over a spot which is strown with many blocks of a fine-grained, gray granite, containing black mica. This is doubtless the bed-rock here, at a little depth below the surface.

About a mile farther southwest, some forty rods below McClure's landing and a quarter of a mile above the mouth of Cowan's brook, probably in the N. W. ¼ of the S. E. ¼ of section 4, T. 42, R. 23, a medium-grained gray granite, with a little black mica, outcrops in both banks of Snake river and forms a short rapid. These ledges on the left shore extend about forty feet, rising only one or two feet above the water; but on the right bank, a short distance below, they reach a hundred feet or more, having a hight six or eight feet above the river.

An eighth of a mile farther south, a finely-laminated, dark gray mica schist forms outcrops two or three rods long and six feet above the river, in each bank. This has a northerly dip, varying from 5° to 15°. It is traversed irregularly by veins, from one inch to one foot, and on the west bank from one to four feet in width, composed of coarsely crystalline light gray granite, which has crystals of white mica an inch long.

The head of the Upper falls of Snake river is about two-thirds of a mile south from the mouth of Cowan's brook, in the north part of section 9. The first noteworthy ledges beyond those last described are about twenty-five rods below, west-southwest from, the head of these rapids. Here the river flows ten rods westerly between walls of granite only thirty to forty feet apart, with a descent of two or three feet. This is called the "jaws of the Upper falls." The rock here is mainly gray granite, in part fine-grained, but more generally of medium or very coarse grain. It also encloses many veins and masses, from one to eight feet in width, of exceedingly coarsely crystalline granite, with flesh-colored feldspar, or of such feldspar alone; and these in some portions make up nearly half of the rock exposed. Veins of white quartz, up to one foot in diameter, are also present. In some parts this rock has a distinct but much contorted lamination, being thus changed to gneiss and mica schist. Joints, vertical and nearly horizontal or oblique, divide these ledges into blocks from one to five or ten feet in dimension. Because of this structure the channel eroded by the river is enclosed by zigzag, nearly vertical walls, which are 10 to 15 feet high. The same formation, with great lithological variety, reaches twenty to forty rods from the river on each side, and rises 25 to 40 feet above it; and extends with nearly continuous exposures a third of a mile or more along the river south and southwest to the foot of these falls, which is near the mouth of Hay creek, a tributary from the west. Similar rocks, including very coarse granite, occur also at the "roll dam" and at the "gate dam" on this creek, situated respectively three-fourths of a mile and one mile above its mouth. On the east side of Snake river, about thirty rods south of the "jaws of the Upper falls," the rock for several rods is darkish gray gneiss, dipping 30° to 40° S. Some twenty-five rods farther south, it is a medium-grained, light gray granite, containing both black and white mica, the former most abundant; this is a little northeast from a small island in the river, and is about an eighth of a mile north from the foot of these rapids of the Upper falls. This granite by its color and texture promises to be a handsome and easily wrought building-stone. It has more extensive exposures one mile farther southeast along the Lower falls.

A quarter of a mile south from the last, an exposure of dark granite or gneiss extends about ten rods along the southwest bank of the river. It is divided by a conspicuous system of joints which dip about 45° southerly. No outcrop occurs here on the northeast or left bank.

About forty rods southerly from the last, an outcrop of medium-grained, flesh-colored granite forms a small rapid. It occurs in the channel and has small and low exposures on each shore.

The head of the Lower falls is about an eighth of a mile south from the last, being where the river bends eastward in the north part of section 16. Between the Upper and Lower falls, as also above and below them, the land is slightly or moderately undulating till, 5 to 25 feet above the river, which is from three to eight rods wide.

The Lower falls of Snake river lie in the E. ½ of the N. E. ¼ of section 16, T. 42, R. 23, and in the N. W. ¼ of section 15, reaching about three-fourths of a mile, in which the river flows east and east-northeast, falling some twenty feet in this distance by a succession of rapids, but having no great fall at any one place. Along this distance the river is bordered by abundant granitic ledges, roughly ragged, jointed and broken, but rarely vertical, varying from 10 to 30 feet in hight. These rock-outcrops reach twenty to forty rods or more from the river upon each side, and form several east-to-west ridges, an eighth to a fourth of a mile long, rising 25 to 40 feet above the river. They rise most steeply in the south or right bank of the river, owing to a general system of joints which dips about 60° southerly. Throughout this area the principal rock is a medium-grained, light gray granite, desirable for quarrying, like that found fifty or sixty rods south from the "jaws" of the Upper falls. This rock is usually divided by joints at intervals of five to ten feet; and it includes veins and masses of gneiss, mica schist, very coarse flesh-colored granite, and of feldspar; but these are far less frequent than at the Upper falls.

The place of the river's channel across this formation may have been determined by a stratum of dark, partly crumbling mica schist, which seems to be included in the granite. It is seen in each bank of the river along the central and east part of the Lower falls for a distance of a quarter of a mile; its best exposure is in the east part of this distance, where its strike is E. or N. 80° E., coinciding with the course of the river. The dip of this bed is about 75° S., and its thickness appears to be about one hundred feet. This schist encloses occasional seams of white quartz up to three and sometimes six inches in thickness, coinciding with the foliation.

Potsdam sandstone. Below these falls, the only remaining outcrops of rock on the Snake river in Kanabec county are sandstones, in part conglomeritic, which are believed to belong to the Potsdam period. No fossils were found in them. Their first exposure is about one and a half miles southeast from the Lower falls, being at O'Brien's camp, in the north part of section 23, T. 42, R. 23, where the river turns from a west to a south course. Here a dark red sandstone, divided throughout in layers from a quarter of an inch to two inches thick, is exposed in the river's west or right bank for twenty-five rods at and south from its sharp bend, seen at several places to a hight two to six feet above the water. Its best exposure is just below this, reaching twenty rods south-southeast, in the east bank of the river, forming a wall three to eight feet high. The general surface eastward is only about ten feet above the river, but it has no rock-outcrops. All this sandstone is divided in thin layers, which in many places show oblique bedding, varying five to ten degrees from the planes of stratification, which throughout dip 10° to 20° E. N. E. It is further divided by irregular vertical joints, into pieces only six to eighteen inches long. At several places this rock includes many gravel stones, up to a half or two-thirds of an inch in diameter; these are mostly quartzose; and one of soft, red pipestone was found.

In the south part of the next township (41 of range 23), Shumard reports an exposure, twenty-five feet in thickness, of red sandstone and alternating ash-colored clays.

At Knife River bridge, which crosses Snake river in the N.E.¼ of section 3, T. 39, R. 23, about three miles east-southeast from the exposures of granite near Ann Lake dam, this sandstone is exposed for a length of about 300 feet and a width of 75 feet, on the south-west or right shore of the river. It has mainly a sloping surface, rising from the water's edge to about five feet above it; but at its east end for nearly 100 feet it has a vertical outcrop, rising in its highest part seven to ten feet above the river. This rock is a coarse-grained sandstone, of gray and iron-rusted color, divided by weathering into layers from a quarter of an inch to one and a half inches thick. Mainly it has an eastward dip, which appears to be slightly variable in amount and direction. At one place, the steepest noticed, the dip is 15° E. S. E. In some layers this rock has a deep dull red color for three or four inches vertically through a length of six to ten feet. This entire outcrop encloses pebbles here and there, mostly quartz or quartzose, of all sizes up to three and a half inches in diameter, but they are nowhere so plentiful as to give the rock the character of an ordinary conglomerate.

The foregoing comprise all the exposures of rock known in Kanabec county.

PINE COUNTY.

Crystalline schists. The most northern outcrops of rock learned of in this county, are in the east part of its northwestern township (T. 45, R. 21), where schist, conspicuously veined with white quartz, is reported as forming knobs 40 to 75 feet high and extending two miles or more in a course from southwest to northeast. Toward the southwest this formation appears in Kanabec county at the Upper and Lower falls of Snake river, and in Aitkin county at the dam on this river, situated in the S. W. ¼ of section 21, T. 43, R. 23, a few miles above these falls, and again in the north part of the same township, a few miles above this dam and a half to one mile below the fork of Snake river. Northward, it is exposed in Carlton county at the mouth of Split Rock river, tributary to the Kettle river from the west in section 32, T. 46, R. 20, and six miles farther east in the vicinity of Moose Lake station, which is two and a half miles north of Pine county line.

The last of these localities is the only one which I have examined. The southern limit of the rock exposures here is near Fox & Wisdom's steam saw-mill, a mile south of the depot. Thence northward the rock lies for two thirds of a mile partly on each side of the railroad. From the village its area reaches west a half mile, and continues about a mile farther north at some distance west of the railroad, rising in moderate slopes 25 to 40 feet above the railroad and lake. It is mainly a darkish gray hydromica schist, considerably contorted, with variable dip, its lamination being sometimes horizontal, but usually dipping 15° to 25° S. or S. 15° E. Quartz veins, mostly from an eighth of an inch to three inches, and rarely from one to four feet, in thickness, are frequent. A vein, or dike, only about an inch in thickness, of dark, columnar trap, was found half a mile west of the station. Part of this rock, especially northward, is very fine-grained and compact, resembling quartzyte, and having a dark slate color. This usually shows no distinct lamination and has no slaty cleavage, but it is much divided by joints into rhombic masses one to two feet long. Other portions of this outcrop are traversed by joints from one to ten feet apart; their principal system is nearly vertical and runs from north to south or S. 10° E.; fewer joints cross these, bearing southwest or nearly from east to west. Through all the extent of this rock, it is very much broken upon the surface into a multitude of angular blocks from one to ten feet in dimension, so that on a large part of its area considerable search is needed to find it in undisturbed position.

Sandstone. An area of sandstone, shown on the map as belonging to the Potsdam period, but which upon further consideration seems to be more probably referable to the lower part of the St. Croix formation, is found on the Kettle river in Pine county from about three miles north of Kettle River station southward along a distance of nearly twenty-five miles. The most northern outcrop of this sandstone is reported in a bluff at the west side of Kettle river, near the southwest corner of section 10, T. 44, R. 20. Its next exposure is some two miles south of Kettle River station, in the S. E. ¼ of section 3, T. 43, R. 20, where it rises about ten feet in the northeast bank of Kettle river. Here and frequently onward to the mouth of the Grindstone river, this rock forms the river-bed and produces rapids. Where the old Government road crossed the Kettle river, a mile below this reef, the sandstone rises 10 to 15 feet in its right bank. Through the next fifteen miles, to about a mile below the Grindstone river, a deep channel has been eroded by the Kettle river in this formation, which is seen almost uninterruptedly along both sides, often making a wall 5 to 20 feet high at the water's edge, and ascending within a distance of an eighth to a third of a mile from the stream in bluffs 75 to 100 feet high, their upper half being usually vertical cliffs. Occasionally tower-like masses are left isolated beyond the line of the bluff, the edge of which, also, is in many places broken into immense blocks, some of which have been already dislodged, while others are separated by yawning chasms, from one to six feet or more across and ten to twenty-five feet deep, ending in cavernous clefts and recesses below. This whole gorge fifteen miles long, like that of the Mississippi eight miles long from Fort Snelling to Minneapolis, has probably been cut by the river since the ice age. The drift in the vicinity of Kettle river is thin, and the sandstone reaches from the base to the top of its bluffs, which rise to the general level of the adjoining country. On tributary ravines and creeks this rock often forms picturesque cliffs to a distance of a half mile or one mile above their mouths; but farther back the water-courses are usually of small depth, not cutting through the moderately undulating drift-sheet, and only few exposures of the underlying sandstone are known. This sandstone is mostly fine but partly coarse in grain, rarely conglomeritic, seldom very hard and sometimes easily crumbling, usually gray or buff in color, and in stratification nearly level or inclined only a few degrees.

At the Upper falls (or Dalles) of the Kettle river, situated four miles east of Miller station, in the south edge of T. 43, R. 20, the river flows southwest in rapids about a half mile long, closely bordered upon each side by ragged cliffs of this rock, 50 to 100 feet high. About a sixth of a mile below the foot of this rapid, a little stream joins the river from the west, having a pretty waterfall, 13 feet high, a dozen rods above its mouth. Here the sandstone rises in successive steps of ten to twenty feet each, often overhanging, to a hight about 75 feet above the river. It is fine-grained, slightly reddish or yellowish brown, and bedded in layers from six inches to three feet thick. These layers are nearly level, but resemble many modern sand deposits in being often obliquely laminated, their dips varying from 10° to 45°, mostly southward. On the small tributary mentioned, this sandstone forms a picturesque ravine extending about a mile northwestward from the river. At a basin near the head of this gorge, it dips about three feet in a hundred feet, or approximately two degrees, to the southeast.

The Lower falls of Kettle river are in the south part of section 15, T. 42, R. 20, being a short distance below a very large chalybeate spring which issues at the foot of the eastern bluff, and about a mile south of a tributary whose loudly dashing descent down this bluff is hidden from view by its heavy woods. In the three miles between these falls of Kettle river, it flows with a gentle current.

At the Lower falls the sandstone forms both shores and the river's channel, in the middle of which it rises in an island with vertical walls and nearly level top, about a hundred feet across, and 10 or 12 feet above the water at the head of this fall. West of the island is a perpendicular descent of four or five feet, with rapids which fall two feet within a few rods above, and as much more within twenty rods below, making a total of about eight feet. East and south of the island the descent is a nearly continuous rapid, broken by vertical falls of only about one foot. The sandstone here is fine-grained and somewhat friable; its color is yellowish gray; and its stratification, in beds from six inches to three feet thick, has a slight dip to the south, varying from one to four feet in a hundred feet.

In sections 16 and 17 of this township, one and two miles west from the Lower falls. exposures of this sandstone occur on the south side of a small brook, 10 to 20 feet above it, and at the general level of the surrounding drift-covered country. In the west part of section 17, it is hard and fine-grained, and was quarried several years ago to test its value as a grindstone.

At Hinckley, on the Grindstone river four miles above its mouth, this sandstone has been quarried by the Saint Paul & Duluth railroad company. The section thus exposed is six to nine feet high and about 250 feet long from north to south, lying close north of the river and east of the railroad. The top of this ledge is twelve feet above the river, and is overlain by three to eight feet of very coarse gravel, nearly like till. This rock is a hard and compact, medium-grained sandstone of light buff color, nearly level in stratification. Its beds vary from one inch to two feet in thickness, and in some portions they show oblique lamination, which is inclined 10° to 15° northward. Quarrying was begun here in 1878, since which time this stone has been largely used for bridge-masonry.*

This rock is reported to occur frequently in large blocks, and perhaps has low outcrops in place, along the north branch of Grindstone river, and about Grindstone lake. Below Hinckley this river has cut its channel about fifty feet deep in drift deposits, and no exposures of rock in place were found. From its mouth north along Kettle river, the sandstone occurs in the bluffs, has extensive exposures where the old Government road crosses Deer creek, and forms Pine Island rapids, about four miles south of the Lower falls. A half mile to one mile below the mouth of Grindstone river, ledges of sandstone, nearly level in bedding, light gray in color, and often containing fine gravel up to an eighth or a fourth of an inch in diameter, occur a short distance west of Kettle river, having a hight 20 to 40 feet above it. On the east side of Kettle river here and probably at many places through several miles farther southeast, to the head of the rapids which reach thence to its mouth, a line of broken sandstone bluffs, declining southward from 50 to 25 feet in hight, is found a fourth to a third of a mile from the river.

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* Glacial striæ, seen here at several places, run S. and S. 5° W., by the true meridian.

The next observation of sandstone southeastward is by Owen, who reports it on the southeast side of the St. Croix river a little below the head of the Kettle River rapids. It is red, much shattered, and is underlain by a conglomerate. Near by are numerous outcrops of cupriferous eruptive rock.*

Copper-bearing trap. My examination of the trappean rocks and their beds of tufaceous conglomerate, includes the three miles of Kettle river next to its mouth, and also two ledges seen in its west bank about a mile below the mouth of Grindstone river; outcrops of these rocks on the St. Croix below Kettle river; and their belt crossed by the Snake river in the three miles next east from Chengwatana. Numerous other outcrops of these rocks are reported by Owen and Shumard along the upper three miles of the Kettle River rapids of St. Croix river, and on Kettle river in the distance of about ten miles between its portions here described.

In northern Michigan this trappean formation is rich in copper, which is there extensively and profitably mined. Its continuation westward in northern Wisconsin, on the north shore of lake Superior, and in Pine and Chisago counties, contains generally traces of copper ores, often green in color, most abundant in seams and veins and in decomposing portions of the rock, and rarely particles or even considerable masses of native copper are found in it; but no profitable mining has been yet found upon its areas in Minnesota.

The most northern exposures of trap on the Kettle river are in T. 41, R. 20. The ledges seen by me in this township are situated about twelve rods apart, in the southwest bank, a mile below Grindstone river, being near the northeast corner of section 27. The southern of these outcrops is about seventy-five feet long and rises three to five feet above the river; and the northern has about half this length and hight. Both are trap, somewhat decomposed, of dull red or dark rusty color, partly amygdaloidal, and much divided by irregular joints and cracks into fragments from one to twelve inches long.

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*East and northeast from the Kettle River rapids on the St. Croix, no outcrops of the bed-rock have been learned of in Pine county, by much inquiry addressed to surveyors and lumbermen who are familiar with this part of the St. Croix and with its tributaries, Bear, Sand, Crooked and Tamarack creeks. The region consists chiefly of till, rising by gentle slopes to hights 25 to 30 feet above the streams, and is well-timbered with hard wood and much red and white pine.

Kettle river from the east line of T. 40, R. 20, to its mouth, a distance of about six miles, consists of a succession of rapids, alternating with portions that have a gentle current. My notes cover the lower half of this extent, beginning at the elbow where the river bends from a south to an east course, in the southern part of section 32, T. 40, R. 19. At this bend and eastward an outcrop of trap extends about twenty-five rods in the southwest bank, rising perpendicularly at each end about ten feet above the water, but in its middle portion having a hight of only two or three feet. Much of this rock is the usual dark and tough trap; it is minutely pitted upon weathered surfaces; and is often divided by joints into rhombic masses from three inches to two feet long. Some portions are amygdaloidal, holding green bunches of chlorite and epidote, apparently because of decomposition and metamorphism. Veins of calcite in the form of satin spar, from a sixteenth of an inch to one inch in thickness, and sometimes ten feet or more in length, occur in many of the joints, vertical, oblique and horizontal, in the decomposing parts of these ledges.

About a half mile farther east, near the center of the S. W. ¼ of the S. W. ¼ of section 33, trap is exposed in the northeast bank of the river, having an extent of a few rods and rising about five feet above low water. This is known as the "copper claim," from prospecting shafts sunk here by Mr. N. C. D. Taylor, in 1865.

Here the river turns south and holds this course to its mouth. A little below the "copper claim," in the north part of the N.W. ¼ of section 4, T. 39, R. 19, its east shore is trap, declining in hight from ten to two feet along its extent of about forty rods from north to south, overlain by a bluff of red till, 25 to 30 feet high.

Next this rock outcrops at many places on the west shore of the river along a distance of nearly a quarter of a mile, at the middle part of the west side of this section 4. It rises one to five feet above the river. Generally it is somewhat decomposed, being often oölitic and nodular, with frequent green stains. Small portions of it are tufaceous conglomerate. It is much divided by joints from two to eighteen inches apart, varying in inclination from 45° to vertical. Their most conspicuous system of parallel planes has an east-northeast strike. All this lower part of Kettle river has low shores or bluffs only 25 to 40 feet high, and the adjoining country is moderately undulating drift.

The mouth of Kettle river is divided by two small islands into three channels. Opposite to its mouth and for three miles above and one mile below, the St. Croix river is turned in two channels, by three long islands, which together are called the "Big island." The eastern, large channel is the state boundary; and the western is commonly called the "slough." In both the river has a strong current, with numerous rapids, the largest fall being two or three feet in a few rods at a reef of trap which crosses both channels near the middle of the upper island. This extent of about four miles on the St. Croix river is named Kettle River rapids. The highest outcrops of trap in this distance rise only 10 to 20 feet above the water.

Descending the St. Croix from the mouth of Kettle river, the first rock was found at the south end of the "Big island." Here very compact and hard, dark trap has an extent of about twelve rods from east to west and a hight of five feet.

About a mile farther south, near the south line of section 20, trappean rock, nearly like the last, divided by joints one to four feet apart, forms the west shore of the river for ten or twelve rods, reaching five to ten feet above the water. It again has an exposure of similar extent in the same bank some fifty rods farther southwest, being in the N. W. ¼ of section 29, T. 39, R. 19, about twenty-five rods below the north end of the "Thousand islands," where another ledge of this rock occurs.

The most southern outcrop of trap on this part of the St. Croix is found on the Wisconsin side about a half mile south from the last. Its visible length is only about ten feet, and its hight six feet. Forty rods farther south, opposite to the last of the "Thousand islands," is the most northern point on the St. Croix river at which I observed the St. Croix sandstone, which thence is frequently exposed along a distance of nearly twenty miles to the south.

The southwestward continuation of this area of copper-bearing trap is found on the Snake river at Chengwatana and for three miles east. Farther southwest the bed-rocks are universally concealed by the drift, as also along this river above to its sandstone outcrops in Kanabec county. Chengwatana dam, in Snake river at the mouth of Cross lake, is built on ledges of trap and conglomerate, which here and in their other outcrops, seen at several places within the next mile, and two and three miles below, rise five to fifteen feet above the river. Their exposures are restricted to its channel and banks, and the adjoining region is gently undulating or nearly level drift, 20 to 50 feet higher. The greater part of this belt consists of dark, hard and compact, fine-grained, tough trap. Other portions show various stages of decomposion and metamorphism, and bear amygdaloidal masses of chlorite, epidote, and other minerals, and veins of calcite.

Search for copper in these rocks was made several years ago by Mr. Adolph Munch, about three-fourths of a mile below Chengwatana, by several shafts of little depth, upon each side of the river and in its channel. During 1880 and 1881, further prospecting for copper was entered upon by the Chengwatana Mining Company, represented by Mr. J. Bennett Smith, who has sunk shafts at three points on the north side of the river, three-fourths of a mile, one mile, and one and a half miles east from Chengwatana. The first of these is in a dark red, ochery conglomerate, which contains many water-worn pebbles, mostly from a half inch to two inches in diameter, apparently derived from the trap, but altered and decomposed. Mr. Smith states that this bed of conglomerate is thirty feet thick, with strike N. 15° E. and dip 70° S. 75° E.. He reports another bed of conglomerate, very coarse, fifty feet thick, a half mile east of Chengwatana, and a third, about twenty-five feet thick, at the mouth of Cross lake, close above the dam.

At the time of my observation here, October 17, 1881, Mr. Smith was at work at the shaft a mile east of Chengwatana, in an amygdaloidal bed, fifty feet in width, dipping 70° S. 75° E. This had been excavated to a depth of 45 feet, below which farther exploration has been since made with a diamond drill. The hanging wall is very hard, fine grained black trap; next to this the first five or six feet are soft, decomposed amygdaloid, holding many chloritic bunches, from a quarter of an inch to two inches in diameter; the central and lower portions are somewhat harder, and contain much calcareous spar in crystalline masses and in banded veins, besides a large variety of other minerals; the foot wall is compact and hard, somewhat amygdaloidal trap. All these beds of conglomerate and amygdaloid have approximately the same strike and dip. Prof. T. C. Chamberlin reports the strike of these strata on the Snake river to be N. 10° to 15° E., and their dip 50° to 60° south of east. The formation was made up by successive overflows of molten rock, which cooled to form hard, finely crystalline trap beneath, but often in the upper part became scoriaceous and amygdaloidal; and between these eruptions, during intervals of repose, layers of tufaceous conglomerate sometimes were accumulated.

St. Croix sandstone. East of this trappean belt, the next exposures of rock on the Snake river are near its mouth. Its northeast bluff in the S. ½ of the N. E. ¼ of section 36, T. 39, R. 20, about a mile above its junction with the St. Croix, has an outcrop of gray and white sandstone, which extends about twenty rods, rising ten to fifteen feet above the river. This is a levelly stratified, somewhat friable rock, in layers from three inches to one and a half feet thick, mostly intersected by nearly vertical joints two to five feet apart. It was quarried a few years ago by Mr. T. R. Rice and others for the foundation of the court house at Grantsburgh, seven miles east in Burnett county, Wisconsin. Two or three feet above the line of low water, this sandstone includes a layer of conglomerate, one foot thick, composed of gravel and pebbles up to an inch in diameter, mostly white quartz, all much water-worn.

Half a mile farther east, where the river turns from a north to an east course, about a hundred rods above its mouth, another outcrop of this formation was seen along an extent of about fifty feet and to a hight of six feet. The lowest beds here, about four feet in hight, are whitish and yellowish, somewhat pebbly sandstone, in layers from a quarter of an inch to six inches thick; in part rhomboidally divided by many joints; levelly stratified at the east, but at the middle of the exposure dipping 1° to 10° southwesterly and disappearing. The overlying beds are soft, finely laminated shales, red, green and yellow. Their red layers are from an inch to one and a half feet thick, rarely enclosing yellow laminæ; and the green vary from one to four inches in thickness, including yellow layers up to three-fourths of an inch thick.

On the St. Croix river similar beds were noted in its southeast bank, opposite to the most southern of the "Thousand islands," a mile above the mouth of Snake river. Here whitish and slightly yellowish, soft sandstone was exposed along a distance of forty feet, and to a hight of ten feet above the water, in the base of a high bluff. It is bedded in horizontal layers, which are obliquely laminated, and vary from three to twelve inches in thickness, sometimes divided by layers a quarter of an inch to one inch thick of greenish sand. Under this sandstone, the three feet next to the water consisted of soft shales, the upper one and a half to two feet being dark red, finely laminated, with occasional thin streaks of green or yellow; then, about a foot of light green color, with little yellow and red, underlain at the water's edge by a second red stratum. An eighth of a mile farther south, this eastern bluff, about 90 feet high, exposes a vertical thickness of fifteen feet of nearly white, level sandstone, 35 to 50 feet above the river.

A quarter of a mile below the mouth of Snake river, this sandstone occurs, thinly covered with alluvium, a few rods north of Mr. T. R. Rice's house, on the Wisconsin side, being eight or ten feet above the St. Croix.

The Horse-race rapids, not broken by boulders, are a half mile long, lying mostly in the N. E. ¼ of section 7, T. 38, R. 19. The next half mile of the St. Croix, two to two and a half miles below Snake river, is bordered on the Wisconsin side by perpendicular cliffs of white, coarse-grained, soft and crumbling, horizontally bedded sandstone, about 50 feet high.

CHISAGO COUNTY.

St. Croix sandstone. At Baltimore rapids, on the St. Croix river a little below the northeast corner of Chisago county, in the N. E. ¼ of section 4, T. 37, R. 20, this St. Croix sandstone forms a bluff on the Minnesota side, 50 feet high and a quarter of a mile long.

In the southwest quarter of this section, about a half mile below the last, ledges of sandstone, light gray in color, coarse-grained and rarely including white quartz pebbles up to three-fourths of an inch in diameter, friable, and level in stratification, occur at two or three points within an eighth of a mile on the Wisconsin side, rising 10 to 15 feet above the river.

An eighth of a mile farther southwest, the same stone rises on the Minnesota side in a vertical and overhanging cliff twenty feet high and about fifteen rods long, known as the "big rock." It is the last prominent ledge seen in descending the St. Croix before coming to the high outcrops of trap in the southeast part of this county.

Only two localities of rock-exposures are known in the intervening distance of twenty-five miles, both being sandstone with the characters already described. These are at a fall of about ten feet on Rush creek a half mile above its mouth, and at Yellow Pine rapids in the St. Croix, on the east side of section 18, T. 36, R. 20, where low ledges of this stone are seen in its channel and banks along a distance of nearly a mile.

This sandstone and its included shales are exposed at many places in the bluffs of the St. Croix river at St. Croix Falls and Taylor's Falls, and through Franconia, the southeastern township of this county. In stratification all these beds are nearly horizontal and show no indications of any disturbance or metamorphism since their deposition. They reach from the level of the river to hights 50 to 100 feet above it, and are overlain by the glacial drift. Where they lie in contact with the steep, vertical, or overhanging sides of the trap rocks which here form the Dalles of the St. Croix, they are often changed to conglomerate, containing many fragments that fell from these cliffs, which had already been deeply eroded before the St. Croix sandstone and shales were deposited. These sediments contain multitudes of shells of *Lingula* and *Orbicula* species, and trilobites occur rarely; but no fossils have been found in any of the strata which lie farther north, described in the foregoing pages.

At St. Croix Falls, in Wisconsin, fossiliferous shales, mostly gray, but in some beds green, often bearing films of iron rust in their crevices and joints, and including thin layers of sandstone, are seen from the river's shore to a hight of 50 feet. These shales also form the Minnesota bank of the river, about 30 feet high, between twenty and forty rods north of the Taylor's Falls bridge.

In the two miles between the Upper and Lower Dalles, the formation is a whitish or yellowish gray, soft, often friable, sandstone, exposed in the bluffs west of the St. Croix to the hight of about 100 feet. Near Taylor's Falls it has been somewhat quarried for use as a building stone.

At Franconia, close below the Lower Dalles, it reaches in the bluff of Lawrence creek at Paul Munch's mill to a hight of about 70 feet above the creek or 90 feet above the St. Croix. Its upper 40 feet are a gray, thick-bedded sandstone, which is rather friable, but hardens after quarrying; it supplied the stone of which this mill was built, fifteen years ago. The next 12 feet are finely laminated, slightly sandy shale, soft, but hardening by exposure, green and iron-rusted, superficially ash-colored; and the 20 feet at the base are dark-greenish sandstone, soft and incoherent at the weathered surface.

The ravine of Lawrence creek for a half mile above this mill is enclosed by cliffs of this sandstone, mostly like the upper part of the foregoing section, rising 50 to 75 feet above the creek, and in their highest portion about 125 feet above the St. Croix. Myriads of *Lingulæ*, difficult for preservation, excepting as fragments, because of the crumbling character of the stone, occur in these beds on each side of the creek, an eighth to a fourth of a mile north from the mill, at about the hight of the flume. The dip here is one to one and a half feet in a hundred, or about three-fourths of a degree, southward.

Travertine, a limestone deposited from the water of springs, occurs in large deposits on the face of the bluffs of this sandstone, and has been extensively burned for lime, a quarter to a half of a mile south of Munch's mill in Franconia, and near Osceola, a few miles farther south on the Wisconsin side. At the latter place, nearly opposite to the southeast corner of Chisago county, the St. Croix sandstone is thinly capped by the Lower Magnesian limestone, which thence southward overlies this formation along the St. Croix and Mississippi rivers.

Copper-bearing trap. The remarkable outcrops of trappean rocks forming the picturesque and grand Dalles of the St. Croix, are more than thirty miles south of the areas of these rocks in Pine county. About a mile above Taylor's Falls and close above St. Croix Falls, trap occurs in the channel and on both sides of the river, its highest portions having an elevation of 50 feet. At Taylor's Falls the St. Croix enters its Upper Dalles, where for three-fourths of a mile it is walled on both sides by bold, often vertical, ragged cliffs, 75 to 150 feet high, of tough, nearly black, massive trap. This gorge and the similar one of the Lower Dalles, about a quarter of a mile long, close above Franconia, have been cut in this rock by the river, the excavation being aided by nearly vertical joints. At Taylor's Falls landing these bear N .60° E. and N. 45° W.

East of the road to this landing, the ledges of very hard trap, 25 to 60 feet above the river, are surprisingly water-worn, with many pot-holes of all sizes from those only one and a half feet in diameter and six feet or more in depth, almost perfectly cylindrical, to the caldron, situated six rods northeast of the landing, twenty feet in diameter, circular, and ten feet deep with perpendicular sides to the surface of the water which partly fills it. Into one of these wells, eight feet in diameter, a pole has been thrust down thirty feet.

The origin of this formation, as in Pine county and in the lake Superior region, appears to have been by overflows of molten rock poured out from fissures of the earth's crust; but only inconsiderable portions of the beds exposed here are amygdaloidal, and this structure is rarely seen to be characteristic of distinct layers. A general system of jointage planes, which is quite noticeable in these outcrops, dipping about 15° W. by S. is regarded by Professor Chamberlin as parallel with the planes of bedding of the trappean overflows, at first nearly level, but subsequently disturbed and tilted. He further remarks that these rocks and those of Pine county are bent in a synclinal, like their broader continuation northward, which forms the depression of lake Superior; and that this continuously synclinal belt is slightly curved upward, saddle-like, between the lake and its southern extremity in the St. Croix basin.

A band of conglomerate, the only one observed in the exposures of trap in this region of the Dalles, is reported by Mr. D. A. Caneday, in a ravine on the Minnesota side, nearly a mile southwest from the bridge; being a layer eight feet thick, dipping 15° westerly, overlain and underlain by trap, which is dark above and reddish beneath.

Exploration for copper and silver has been made in the trap formation at Taylor's Falls by three shafts. A short distance east of the Lutheran church on the road to Franconia, Mr. N. C. D. Taylor went to a depth of 43 feet, finding films and small masses of native copper. This is near the highest part of these trappean ledges, about 200 feet above the river, and 50 below the average hight of the rolling drift which universally covers the bed-rocks from the top of this river-bluff westward. The two other shafts were sunk by the Taylor's Falls Mining Company, one being near the river, and the other about 75 feet above it, on Ravine street. The last was worked in 1874 and 1875, and reached a depth of 120 feet, following a vein eight to ten feet wide, which dipped to the west about 85°, or ten feet away from a plumb-line. This vein contained ores of both copper and silver. An apparently metalliferous vein, four feet wide, with strike nearly from north to south, is seen on the surface about half-way between this and Mr. Taylor's shaft. Another, eighteen inches in thickness, dipping 12° W. S. W., is described by Mr. Caneday, near the foot of the Upper Dalles, at a little hight above the river; the four inches next to the hanging wall being bornite, a sulphuret of copper and iron, with about a foot of white quartz and a thin earthy layer below.

IV.

LAKE AGASSIZ: A CHAPTER IN GLACIAL GEOLOGY.

[Read before the Minnesota Academy of Natural Sciences, Jan. 6th, 1882.]

BY WARREN UPHAM.

In the last of the geologic ages a very cold climate covered the north part of our continent with ice. Every year the snowfall was greater than could be melted away in summer; and its depth gradually increased till its lower portion was changed to compact ice by the pressure of its weight. This pressure also caused the vast sheet of ice to move slowly outward from the region of its greatest thickness toward its margin. Our reasons for believing that there has been such a wonderful glacial period, are abundant and must convince anyone who gives attention to them.

The surface of the bed-rock at the quarries in this city [Minneapolis]. on Nicollet island and beside the Mississippi farther east, bears fine scratches and markings, called *striæ*, like those which are found beneath the glaciers of the Alps. Only one cause is known which can produce markings like these, and this is the rasping of stones and boulders frozen in the bottom of a moving mass of ice, accumulated upon the land in a solid sheet of great extent and depth. As these striæ are found upon the rocky surface of British America and of the northern United States to a southern limit that coincides approximately with the course of the Ohio and Missouri rivers, we must conclude that an ice-sheet has covered these regions.

The superficial material that overlies the bed-rock within this northern glaciated area has everywhere been ploughed up and worked over by the slowly moving ice-sheet, and at its disappearance was left in a deposit of clay, sand, gravel and boulders, mixed in one confused mass, which is called *till.* Except in the valleys, as of the Mississippi at Minneapolis, where streams have assorted these materials and spread them in layers, the till forms the surface of nearly all of Minnesota, its thickness being from 50 to 250 feet. It is the stony and gravelly clay, in which cellars and well are dug; and it forms a sheet of such great extent and thickness that about half of the counties of western Minnesota contain no exposures of the underlying older rocks.

The thickness of the ice-sheet was so great that its striæ and transported drift are found on the top of mount Katahdin, of the White mountains, and the Adirondacks; and over northern Minnesota it was probably of equal depth, or about a mile thick. By the direction in which the boulders have been carried from their original ledges, and by the courses of the glacial markings, we know that the ice moved in general from north to south. In New England its current was southeastward, and the border of the ice-sheet was pushed into the Atlantic to the fishing banks south of Newfoundland and east of cape Cod. Over Canada and the region of the great lakes, the ice-flow was southwestward. A glacial current moving in this direction has spread upon eastern Minnesota a red till, thus colored by the hematite, or anhydrous sesquioxide of iron, contained in the red quartzyte, sandstone and shales of lake Superior, which were eroded by this ice-sheet. In western Minnesota the ice flowed southward from lake Winnipeg to Big Stone lake and thence southeast into northern Iowa, spreading a blue till, with many boulders of limestone.

Terminal moraines, or hills, knolls and ridges of drift heaped at the border of the ice-sheet, are found stretching in a remarkably curved and looped course across Wisconsin, Minnesota, Iowa and Dakota. The line of this formation in Minnesota reaches from Stillwater and Saint Paul northwest to the vicinity of Saint Cloud and to the Leaf hills, this part being at the limit of the ice-current which came from lake Superior; then from the Leaf hills south by Glenwood, lake Minnetonka, and Albert Lea, into Iowa to the vicinity of Des Moines, this part being pushed out at the east side of an extensive lobe of the ice-sheet, whose central current went south and southeast; then, on the west side of the same glacial lobe, its terminal moraine has been traced from central Iowa northward by Spirit lake and lake Benton to the Head of the Coteau des Prairies, twenty miles west of lake Traverse. This moraine was formed at the margin of the areas that were overspread by the ice of our last severely cold epoch.

At some earlier time of the same great glacial period, the ice-covered area extended much farther south, to northeastern Kansas, into Missouri to Saint Louis, and to southern Illinois, Indiana and Ohio. Within this area and entirely surrounded by the ice-sheet, a district about 150 miles long from north to south and 100 miles wide, lying in southwestern Wisconsin and adjoining parts of Illinois, Iowa and southeastern Minnesota, was singularly exempted from glaciation. The picturesque bluffs of rock along the Mississippi from lake Pepin to La Crosse and southward, often standing out isolated and alone like the ruins of turreted castles, are in the region which has no till and has not been planed and smoothed by the ice-sheet.

The end of the glacial period was brought by the genial influence of a milder climate when the surface of the ice-sheet was melted faster than it was replenished by the snowfall. Its depth and extent could no longer increase, but were thenceforth gradually diminished. While the ice had been growing deeper and much of the snow that fell each year remained unmelted, its surface was probably as smooth and nearly level as our most uniform and monotonous tracts of prairie ; and its vast area was one white expanse, unflecked by pebbles, earth or even dust, excepting close to the border where its progress was stayed by melting and the drift which had been gathered into the ice-mass became exposed on its surface and was carried forward and heaped at its margin.

At the departure of the ice, the scene was changed. Its surface upon large areas, reaching probably two or three hundred miles from its edge, was hollowed into basins of drainage and channeled by streams which flowed between walls of ice. The boulders, gravel, sand and clay mingled in the ice, mostly in its lower portion, were exposed by this melting, so that at length, when only a small thickness of the ice was left, its surface must have been covered by the drift which it had contained.

The portion of North America which was overspread by the ice-sheet, and from which it disappeared in this way, was of great extent, reaching from the north part of the United States to the Arctic ocean, and from New England to Dakota and westward in British America to the Pacific. The melting and recession of this ice began at its southern border and slowly proceeded northward.

Wherever there was free drainage away from the ice-sheet, a large part of the materials of the drift which had been gathered up into it fell in a comparatively loose, unstratified mass, forming the upper part of the till with its moderately undulating surface, and covering the land upon which the ice had lain, whether this was bed-rock, a ground-moraine, or till formed in an earlier glacial epoch.

Other parts of the drift held in the ice were washed away by its streams and deposited as *modified drift*, forming layers of gravel, sand, and fine silt, in the valleys along which the flood supplied by its melting descended toward the ocean. The high water of the rivers, like that which now occurs for a few days in the freshets of spring, was then maintained through the entire summer, and this was repeated yearly till the glacial sheet had retreated beyond their lines of watershed. The abundant supply of sediment through this time gradually lifted these floods upon the surface of thick and wide plains, sloping with the valleys.

After the departure of the ice, the supply of both water and sediment was so diminished that the streams could no longer overspread these flood-plains, and add to their depth, but were thenceforth occupied mainly in slow excavation and removal of these deposits, leaving remnants of them as plains or terraces, sometimes 100 to 200 feet, or more, above their present channel. The conspicuous bluffs of loess bordering the Missouri river were formed in this way. Along the Mississippi the flood-plain of modified drift at Brainerd and Saint Cloud has a hight about 60 feet above the river ; at Clearwater and Monticello, 70 to 80 feet ; at Dayton, 45 feet; and at Minneapolis, 25 to 30 feet above the river at the head of St. Anthony's falls.

This review of the condition of Minnesota during the glacial period prepares us to understand how the glacial *Lake Agassiz* was formed in the basin of the Red river of the North and of lake Winnipeg during the final melting and gradual recession of the ice-sheet. It thus belongs to the closing epoch of the ice age, when the continental glacier, subdued by a more temperate climate, was yielding its ground between northwestern Minnesota and Hudson bay. During this retreat free drainage from the melting ice could not take place, because the descent of the land is northward. As soon as the border of the ice had receded beyond the watershed dividing the basin of the Minnesota from that of the Red river, it is evident that a lake, fed by the glacial melting, stood at the foot of the ice-fields, and extended northward as they withdrew along the valley of the Red river to lake Winnipeg, filling this valley and its branches to the hight of the lowest point over which an outlet could be found. Until the ice-barrier was melted upon the area now crossed by the Nelson river, thereby draining this glacial lake, its outlet was along the present course of the Minnesota river. At first its overflow was upon the nearly level, gently undulating surface of the drift, about 1100 feet above the sea, at the west side of Traverse and Big Stone counties; but in process of time this cut a channel here 125 to 150 feet deep, and from one to two miles wide, in which lie Traverse and Big Stone lakes, respectively 970 and 962 feet above the sea. From this outlet the Red river valley, 30 to 50 miles wide, stretches 315 miles north to lake Winnipeg, which is 710 feet above the sea. Along this entire distance there is a very uniform continuous descent of a little less than one foot per mile. The drift contained in the ice-sheet upon this area, and the silt gathered by its glacial rivers, were here deposited in a lake, shallow near its mouth, but becoming gradually deeper northward. Beyond our national boundary this lake covered a large area, varying from 100 to 200 miles in breadth at and west of lake Winnipeg; and its total length appears to have been at least 600 miles. Because of its relation to the retreating continental ice-sheet, this lake has been named in memory of professor Louis Agassiz, the first prominent advocate of the theory that the drift was produced by land-ice.

Under the direction of professor Winchell, the state geologist, it was a part of my work last summer to trace the course, and determine the hight, of the shore-line of this ancient lake. This was done in July and August, the only months of the past season which had sufficiently dry weather for entirely satisfactory progress in such exploration. Horace V. Winchell was my efficient assistant as rod-man in the work of leveling, by which the hight of the upper beach was ascertained along its whole extent examined. This was about 175 miles, following the course of the old shore, extending from lake Traverse to the north side of Maple lake, twenty miles east of Crookston. The distance that it includes from north to south is 142 miles.

BEACHES OF LAKE AGASSIZ.

[For a map of these, see fig. 3, plate 1.]

The upper or Herman beach. Along nearly the whole of this distance there exists a remarkable deposit of beach gravel and sand, forming a continuous, smoothly rounded ridge, such as is found along any part of the shores of the ocean or of our great lakes where the land sinks in a gently descending slope beneath the water-level. Usually the beach of lake Agassiz is a ridge three to ten feet above the land next to it on the side that was away from the lake, and ten to twenty feet above the land adjoining it on the side where the lake lay. In breadth this beach-ridge varies from ten to twenty-five or thirty rods. It is thus a broad wave-like swell, with a smooth, gracefully rounded surface.

Such being a section across the beach, remember that this ridge extends along the whole distance that we have explored, with only here and there gaps where it has been cut through by streams and rare intervals of a quarter or a half mile or at the longest two or three miles where the outline of the lake shore, or the direction of the shore-currents, prevented such accumulation. We find similar interruptions in the beaches of present lakes and on the sea-coast; and like these modern deposits the beach of lake Agassiz varies considerably in its size, having in any distance of five miles some portions five or ten feet higher than others, due to the unequal power of waves and currents at these parts of the shore. The moderate slope of the land toward lake Agassiz was favorable for the formation of a beach-ridge, and it has been clearly traced as one continuous formation along this distance of 175 miles. In calling it continuous, we mean that whenever it is interrupted it is found a little distance farther along, beginning again at very closely the same hight.

The gaps where the beach is not a distinctly traceable ridge-like deposit of gravel and sand, cannot exceed one-twentieth of its whole course. In a few places the lake has undermined its shore, forming a terrace in the till, with no definite beach-deposit, the work of the waves having been to erode and carry away rather than to accumulate. In other places, sometimes two or three miles in length, the area where this ancient lake had its margin is a marsh or shaking bog, full of spring water, and rough with hummocks of grass, which grows luxuriantly, but is safe from the hay-makers because teams cannot be driven upon these tracts.

Nearly everywhere along the course of this beach of lake Agassiz the land upon each side is till, or unstratified clay, containing some intermixture of sand and gravel and occasional stones and boulders. The material of the beach-ridge is remarkably in contrast with this adjoining and underlying till, for it includes no clay but consists of stratified sand and gravel, the largest pebbles being usually from two or three to six inches in diameter.

When lake Agassiz stood at its greatest hight and formed the upper beach, its outlet was about 85 feet above the present surface of lake Traverse, or 1055 feet above the sea. The channel which at this time had been excavated in the drift by its outflow was 30 to 40 feet deep along the distance of about fifty miles where now are lake Traverse, Brown's valley, and Big Stone lake. This beach is crossed by the Breckenridge line of the Saint Paul, Minneapolis & Manitoba railway at a point about one and a half miles northwest from Herman.

The Norcross beach. Two lower beaches, of the same character as to form, size, and material, with the highest, were also noted; their course was traced through long distances; and their hight was determined by our leveling. At the next epoch, after that of the upper or Herman beach, when the lake-level was again nearly stationary long enough to form a ridge of gravel and sand upon its shore, the outlet had been eroded about 30 feet deeper than at the time of the upper beach, but was still 55 feet above the present lake Traverse and Brown's valley. The beach of lake Agassiz when it had this lower level is crossed by the Breckenridge railway line at Norcross, five miles northwest of Herman. This is accordingly named the *Norcross beach.* Its course and hight have been determined through an extent of a hundred and fifty miles from Norcross northward to a point twenty-five miles north of Maple lake and ten miles beyond Red Lake Falls.

The Campbell beach. A third series of beach-deposits of similar extent and conspicuous development with the foregoing, was formed when the outlet of lake Agassiz had been lowered some 50 feet more, completing the excavation of its channel to the present beds of Traverse and Big Stone lakes. The beach of this third stage of lake Agassiz crosses the township of Campbell in southern Wilkin county from southwest to northeast, and hence it is denominated the *Campbell beach.* The course of this formation through Wilkin and Clay counties has been noted at a few places, and is thus known approximately. Through its next one hundred miles, from the Wild Rice river to the Tamarack river, it has been traced continuously. For forty miles next beyond Red Lake river the old Pembina trail lies most of the way upon this beach. It has been explored to the north line of Marshall county, sixty miles beyond Maple lake.

Three distinct series of beach-ridges of gravel and sand were thus formed by lake Agassiz at successive stages of hight during its process of deepening the channel by which it outflowed southward.

THE RED RIVER VALLEY.

The central part of the basin of lake Agassiz, within the limits of Minnesota and Dakota, now drained by the Red river, has an exceedingly flat surface, sloping imperceptibly northward, as also from each side to its central line. The Red river has its course along the axial depression, where it has cut a channel 20 to 60 feet deep. It is bordered by only few and narrow areas of bottomland, instead of which its banks usually rise steeply on one side and by moderate slopes on the other, to the lacustrine plain which thence reaches nearly level ten to twenty-five miles from the river. Its tributaries cross the plain in similar channels, which, as also the Red river, have occasional gullies connected with them, dry through the most of the year, varying from a few hundred feet to a mile or more in length. Between the drainage lines, areas often five to fifteen miles wide remain unmarked by any water-courses. The highest portions of these tracts are commonly from two to five feet above the lowest.

This vast plain, twenty-five to fifty miles wide, lying half in Minnesota and half in Dakota, and stretching from lake Traverse and Breckenridge north to Winnipeg, is the widely famed *Red river valley*. The material of the lower part of this ancient lake-bed shown in the banks of the Red river and reaching several miles from it, is fine clayey silt, horizontally stratified ; but at its south end, in Traverse county and the south half of Wilkin county, and upon large areas of each side of this plain, it is mainly unstratified boulder-clay, which differs from the rolling or undulating till of the adjoining region only in having its surface nearly flat. Both these formations are almost impervious to water, which therefore in the rainy season fills their shallow depressions, but none of these are so deep as to form permanent lakes. Even sloughs which continue marshy through the summer are infrequent, but, where they do occur, cover large areas, usually several miles in extent.

On all the area drained by the Red river in Minnesota the glacial drift is so thick that no exposures of the underlying rocks have been found. The depth of the drift here is nearly the same as its average throughout the western half of the state, or from 100 to 250 feet. The prominent topographic features of all this region are doubtless due to the form of the underlying rock-surface, upon which the drift is spread in a sheet of somewhat uniform thickness.

Erosion, before the ice age, had sculptured the rocks which are everywhere buried and concealed under this universal drift-sheet, and had formed the broad nearly level depression of the Red river valley, which is 1000 to 800 feet, from south to north, above the sea. Slopes and terraces of these rocks beneath the drift cause the rise eastward from this valley to the lake-sprinkled plateau, 1300 to 1500 feet above the sea, which reaches from Glenwood, Alexandria and Fergus Falls, to the sources of the Mississippi. For example, though the traveler finds no ledge of rock in going from the Red river at Fargo and Moorhead seventy-five miles east-northeast to Itasca lake, we yet believe that the form of the surface, marked by two remarkable terraces, is due to that of the bed-rock. The flat of the Red river valley extends from Moorhead to about six miles east of Glyndon, with a slight ascent of about 50 feet in these fifteen miles. The next two or three miles rise 200 feet to the top of a terrace which reaches from south to north the whole length of the Red river valley in Minnesota, though it is not all the way so distinct nor so high as here. Beyond this ascent the surface is again nearly level, being a sheet of slightly undulating or rolling till, with a rise of perhaps four or five feet per mile, through twenty-five miles eastward. Next is a terrace, also reaching a long distance from north to south, which is ascended in three or four miles, rising about 300 feet, to the White Earth Agency, which thus commands a very extensive western prospect. Thence a more rolling plateau extends, with little change in the average hight, thirty miles eastward to Itasça lake.

In like manner the elevation of the Coteau des Prairies, in southwestern Minnesota, 1500 to 2000 feet above the sea, and the terrace-like ascent at the west side of the flat Red river valley in Dakota, lying at a distance of twenty to thirty miles west of the Red river, and stretching from the south bend of the Sheyenne river north to the British line where it is called Pembina mountain, are undoubtedly due to the contour of the bed-rock, rather than to differences in the thickness of the drift.

The till upon each side of lake Agassiz has a moderately undulating and rolling surface. Within the area that was covered by this lake it has a much smoother and more even contour, but has been only slightly stratified. The action of its waves gathered from this deposit of till, which was the lake-bed, the gravel and sand of its beaches; and corresponding deposits of stratified clay, derived from the same erosion of the till, sank in the deeper part of the lake. But these sediments were evidently of small amount, and are not noticable upon the greater part of this lacustrine area, which consists of a smoothed sheet of till. The position of the thick beds of stratified fine silt and clay in the central depression of the Red river valley, shows that they were not deposited by the waters of lake Agassiz, which must have spread them more generally over its entire area; but instead appears to prove that they were brought by the rivers which flowed. into this hollow and along it northward after the glacial lake Agassiz had been reduced to its present representative, lake Winnipeg.

Wells within this area show the character and depth of the drift, but none that we have learned of within the basin of lake Agassiz in Minnesota are certainly known to penetrate through this formation. The nearest point in our state at which the exact depth of the drift is known is Herman, about a mile outside the upper beach, where the till or stony clay, yellow near the surface but bluish below, reaches to the depth of 124 feet, beyond which a well was drilled 65 feet in rock, mostly mica schist. At Campbell a well 260 feet deep went all the way in till, excepting occasional layers of sand and gravel, mostly thin, but at one place eight feet thick, from 165 to 173 feet below the top. At Fargo, in Dakota, the first 95 feet were stratified clay; next was a layer of gravel, 10 feet; then till, 115 feet; below which the remaining 42 feet were probably Cretaceous strata, being soft, dark blue shale, 32 feet; coarse sand-rock, 6 feet; and a second shale, 4 feet, in which the well stopped at a total depth of 262 feet.*

Deep wells farther north in the Red river valley are at Ada, 217 feet; near Crookston, 190, 195, and 205 feet; at Grand Forks, in Dakota, 265 feet; at South Angus, eighteen miles north of Crookston, 253 feet; and at Saint Vincent, 165 feet. Perhaps none of these wells, excepting those at Herman and Fargo, reach through the drift; but the two mentioned at Grand Forks and Saint Vincent, which yield salty and alkaline water, may go below it, and if so, the stratified gravel and sand in which they stop are of Cretaceous age.

The fame of this valley for its large harvests of "No. 1 hard" wheat, averaging twenty bushels to the acre, is nearly equaled by the unenviable reputation of the water supplied by its wells. The drift upon this part of the state contains much of the carbonates and sulphates of lime and magnesia, derived from the Cretaceous strata which covered this area and were ploughed up by the ice-sheet, mixed with much drift from the region of granites, gneiss and crystalline schists on the northeast, and redeposited as till. These alkaline ingredients of the soil are often seen in the dry season forming a white or gray efflorescence, resembling frost, sometimes a quarter of an inch thick.

Wheat thrives better where the soil contains a considerable proportion of these alkaline salts, so that their presence throughout the Red river valley is one principal cause of its superiority in wheat-raising; and this, grown year after year, gradually takes away these ingredients and prepares the land for other crops. But their effect as dissolved everywhere in wells and streams partly offsets this benefit, and makes the water of all this region objectionably hard, and often in wells and springs noticeably bitter or salt, especially in the northern part of this valley both in Minnesota and Dakota.

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* Report of U. S. geological survey of the territories, 1872, p. 301.

These waters, too, more readily than pure water, decompose the wooden curbing, which, being the most convenient and cheapest material, is too commonly used in the wells of this region destitute of stone-quarries. Usually these wells after a few weeks or months become offensive to taste and smell; the water is discolored, gives off sulphureted hydrogen, and horses and cattle refuse to drink it or are made sick by it. Let such wells be pumped so as to fill them with new water every day, and these offensive qualities are principally removed. Instead of wood the material for lining wells ought to be stone, iron pipe or bricks, the last of which are manufactured at many places, and may be made almost anywhere, from the stratified clay along the Red river, of excellent quality and at moderate cost.

Artesian wells have been obtained at many places in this valley. Usually in its southern part, as far northward as Crookston, their water has less alkali in solution than the shallower surface wells. The largest flow yet found is on the Fountain Valley farm, owned by C. H. Brush & Co., situated four miles east of Campbell. This well went 56 feet in till to a layer of sand which is known to be 10 feet thick and was not penetrated at this depth, making a total of 66 feet. The diameter of the pipe is one foot, reduced below to seven inches. A large stream of very clear cold water is constantly flowing away from this well, its estimated volume being seven or eight barrels per minute, or about 250 gallons. It has been flowing at this rate more than a year. This water is of excellent quality for house and farm use, but is hard and slightly irony, and deposits a rusty sediment in the channel of the stream. Its temperature is 46 degrees Fahrenheit.

The Ada town-well, 217 feet deep, four inches in diameter, supplies a stream which partly fills a one-inch pipe. It was bored last spring, and has since been running at the rate of about a hundred barrels per day. This water is very transparent, and forms no irony sediment. Its cool temperature, 47 degrees Fahrenheit, and its purity, being called soft water, nearly equal to rain-water for washing, make this a very satisfactory investment for the town. Its cost was about $500.

Another well, nearly like the last in the amount of flow and character of the water, is at E. S. Corser's elevator at Carman, one mile south of Crookston. Its depth is 190 feet.

The deepest well learned of in the Red river valley is at Grand Forks, 265 feet deep. This has an artesian flow; but at the time of my visit in last August, its rate of flow, probably because the pipe had become choked with sand and clay, was very small, not amounting to more than two or three barrels in twenty-four hours. This water has a decidedly brackish taste, and is therefore worthless for any ordinary use. The well at Saint Vincent, 165 feet deep, is of the same alkaline character. Both were bored to supply water for locomotives but cannot be used because of their mineral residue.

It may be that these very deep wells derive their alkaline and salty water from Cretaceous strata; but some shallower artesian wells in this north part of the

Red river valley get quite brackish water from layers of gravel and sand contained in the drift. One of these is on the farm of E. N. Davis, in the south edge of Kittson county, about thirty miles south of the national boundary. This is 45 feet deep, and was bored in a quarter of a day with an ordinary two-inch auger. Its flow has continued nearly constant through more than a year, at the rate of three pailfuls a minute, or more than three hundred barrels daily. Its temperature is 42 degrees. Though salty to the taste, it was drank freely by farm-stock through all last winter with no apparent injury, and it has been used by people as the only water for drinking and cooking through several weeks of drouth. The hight to which it will rise is known to be more than 23 feet, at which hight the flow seemed to be undiminished.

The upward pressure and abundant supply of water in these wells show that the water-bearing layers of stratified drift enclosed in the till are continuous through long distances and descend from a higher level. The veins of soft water found at the depth of about 200 feet at Ada and Carman probably have their sources upon the high land twenty miles distant eastward.

THE OUTLET OF LAKE AGASSIZ.

The excavation of the remarkable valley occupied by the Minnesota river was first explained in 1868 by general G. K. Warren,* who attributed it to the outflow from this ancient lake that filled the basin of the Red river and lake Winnipeg. This valley or channel begins at the northern part of lake Traverse, and first extends southwest to the head of this lake, thence southeast to Mankato, and next north and northeast to the Mississippi at Fort Snelling, its length being about 250 miles. Its width varies from one to four miles, and its depth is from 100 to 225 feet. The country through which it lies, as far as to Carver, about twenty-five miles above its junction with the Mississippi, is a nearly level expanse of till, only moderately undulating, with no prominent hills or notable depressions, excepting this deep channel and those formed by its tributary streams. Below Carver it intersects a belt of terminal moraine, composed of hilly till. Its entire course is through a region of unmodified drift, which has no exposures of solid rock upon its surface.

Bluffs in slopes from twenty to forty degrees, and rising 100 to 200 feet to the general level of the country, form the sides of this trough-like valley. They have been produced by the washing away of their base, leaving the upper portion to fall down and thus take its steep slopes. The river in deepening its channel has been constantly changing its course, so that its current has been turned alternately against the opposite sides of its valley, at some time undermining every portion of them. In a few places this process is still going forward, but mainly the course of the Minnesota river is in the bottomland. Comparatively little excavation has been done by the present river. As we approach its source, it dwindles to a small stream, flowing through long lakes, and we finally pass to lake Traverse, which empties northward ; yet along the upper Minnesota and at the divide between this and the Red river, this valley or channel and its enclosing bluffs are as remarkable as along the lower part of the Minnesota river. It is thus clearly shown to have been the outlet of lake Agassiz, excavated while the melting ice-sheet supplied extraordinary floods, much greater in volume than the combined waters of the Minnesota and Nelson rivers at the present time.

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* Since the above was written, the lamented death of this distinguished soldier and engineer, whose interest in science added much to our knowledge of the geography and geology of the Northwest, occurred Aug. 8, 1882.

This valley in many places cuts through the sheet of drift, and reaches the underlying rocks, which have frequent exposures along its entire course below Big Stone lake. This excavation shows that the thickness of the general drift-sheet upon this part of Minnesota averages about 150 feet.

Lakes Traverse and Big Stone are from one to one and a half miles wide, mainly occupying the entire area between the bases of the bluffs, which rise about 125 feet above them. Lake Traverse is fifteen miles long ; it is mostly less than ten feet deep and its greatest depth probably does not reach twenty feet. Big Stone lake is twenty-six miles long, and its greatest depth is reported to be from fifteen to thirty feet. The portion of the channel between these lakes is widely known as Brown's valley. As we stand upon the bluffs here, looking down on these long and narrow lakes in their trough-like valley, which extends across the five miles between them, where the basins of Hudson bay and the gulf of Mexico are now divided, we have nearly the picture which was presented when the melting ice-sheet of British America was pouring its floods along this hollow. Then the entire extent of the valley was doubtless filled every summer by a river which covered all the present areas of flood-plain, in many places occupying as great width as these lakes.

General Warren observes that lake Traverse is probably due to a partial silting up of the channel since the outflow from the Red river basin ceased, the Minnesota river at the south having brought in sufficient alluvium to form a dam ; while Big Stone lake is similarly referred to the sediment brought into the valley just below it by Whetstone river. Twenty-five miles from Big Stone lake, the river enters Lac qui Parle, which extends eight miles, with a width varying from one-half to three-fourths of a mile and a maximum depth of twelve feet. This lake, as general Warren suggests, has been formed by a barrier of stratified sand and silt which the Lac qui Parle river has thrown across the valley.

THE NORTHERN BARRIER

by which the water of lake Agassiz was restrained from flowing in the direction of the present drainage, to Hudson bay, is supposed by general Warren to have been an elevation of the land much above its present hight northeast of lake Winnipeg. He thinks this elevation was shared by other northern portions of North America, and that these regions have recently been depressed at least several hundred feet. The depths of the great lakes, and many topographic features of the interior of the continent, besides this channel of lakes Traverse and Big Stone and the Minnesota river, appear to him to support this opinion. Instead of this, we believe that the surface of the continent had nearly the same form then as now, and that the continental ice-sheet, resting on the land in a solid mass of great depth, formed the northern shore of lake Agassiz and was the barrier that prevented its flowing into Hudson bay.

Before adducing the evidence, apparently amounting to positive proof, of this glacial origin of lake Agassiz, which is drawn from our exploration of its beaches and determination of their hight, we ought to mention that professor Dana's and general Warren's theory of an elevation of the northern part of the continent, during the ice age or since that time, followed by subsidence to its present hight, is opposed and disproved by the general occurrence of sea-beaches and marine shells above the present sea-level all along our northern shores. They show that the ocean in these recent epochs covered more of the land than now in northern latitudes; that is, that the elevation of the land, as compared with the sea-level, was less instead of greater than at present. More than this, the hight at which these recent marine deposits and sea-shells are found, increases from south to north. In New Hampshire and Maine it is from 50 to 300 feet above our present sea-level; in the St. Lawrence valley, about 600 feet; and on the coast of Labrador, about Hudson bay, and in Greenland, 600 to 1500 feet. Our proof that the ice-sheet was the northern barrier of lake Agassiz, also gives us an answer to the question why the sea-level thus rose higher than now toward the north.

The three series of beach deposits before described (mapped in fig. 3, plate I), which mark the shores of lake Agassiz at as many stages of its hight, have each been traced, and their altitude determined, through an extent of about 150 miles from south to north; and each of them, like the old sea-level, is found to have a gradual ascent northward, as compared with the present level-line, or the surface which a body of water would have now, if confined in this valley. As before stated, these beaches were formed at epochs when the lake-level was nearly stationary for a considerable time during the excavation of its channel of outlet at lake Traverse and southward. The hight of the mouth of the lake and its outflowing river was at the time of the upper or Herman beach 85 feet above lake Traverse; at the time of the Norcross beach this outlet had been lowered 30 feet; and when the Campbell beach was formed, it was nearly at the present level of lake Traverse.

Our exploration and leveling along the upper beach extended from the north end of lake Traverse about 25 miles eastward to Herman and thence about 140 miles north to Maple lake. Through this distance it lies from fifteen to thirty miles east of the Red river. The ascent of this beach northward is at the rate of about four-tenths of a foot per mile in its southern portion for about 60 miles, lying in Traverse, Stevens, Grant, Otter Tail and Wilkin counties. Farther north, through its remaining 80 miles in Clay, Norman and Polk counties, its rate of ascent is considerably greater, varying from three-fourths of a foot to one and a half feet per mile. In all, the surface of lake Agassiz at this time of its greatest hight ascended northward, above a line now level, 125 feet in these 142 miles, from 1055 feet, very nearly, above sea in Traverse county, to 1180 feet, very nearly, at the north side of Maple lake, twenty miles east-southeast from Crookston. Through this distance the upper beach clearly marks one continuous shore-line; and the accuracy of our leveling is attested by close agreement with railroad surveys at five widely separated points.

Before lake Agassiz had fallen below the line of this upper beach in the south half of its explored extent, it had formed a slightly lower parallel beach, three-fourths to one and a half miles distant, through the northern third of Clay county; and this secondary beach, sometimes double or treble, was noted at several places along the next thirty miles northward. The continuation of this beach at the northwest side of Maple lake was accumulated when lake Agassiz had fallen at this latitude about fifteen feet below its highest line. Here it is the second of a series of four well-defined beach-ridges below the upper or first beach, which were formed when the lake had fallen successively about 8, 15, 30 and 40 feet from its highest level. Yet all these beaches were accumulated while the lake remained with only very slight depression of level, not sufficient for the formation of any secondary beach-ridge, along its southern part for some 75 miles northward from lake Traverse and Herman.

The Norcross beach has been explored and its hight measured through a length of 150 miles. In this distance it ascends northward about 70 feet by a nearly uniform slope of a little less than a half foot per mile. The amount that the surface of lake Agassiz had fallen at this time from its highest level was 30 feet in Traverse and Grant counties, 50 feet in northern Clay county, and 90 feet northwest of Maple lake. Its fall in this extent of 150 miles had been thus 60 feet more at the north than at the south end. Double and multiple ridges occur along the northern half of this distance, and show that the lake-level at the time of formation of the Norcross beach fell five to ten feet northward while it remained without change or with less change than was required to form additional beach-ridges southward.

The hight of the Campbell beach, formed when the outlet had been excavated to the level of lake Traverse, is known along a distance of 135 miles, in which its northward ascent was at first 50 feet, and afterward only about 25 feet. This continued depression of the lake northward, while it remained with slight or no change southward, is indicated, similarly with the foregoing, by the occurrence of an additional ridge, along the northern part of the course of this shore-line. The fall of lake Agassiz from the upper or Herman beach to the Campbell beach was about 80 feet at the south near lake Traverse, and 165 feet at the north near Maple lake; and instead of the northward ascent of the upper beach 125 feet in 142 miles, we find the corresponding ascent of the Campbell beach in nearly the same distance at first 50 feet, but reduced later to half this amount.

If the barrier north of lake Agassiz had been land, its subsidence to give way for drainage northward in its present course would cause the beach deposits of the former lake-shores to have the opposite slope, or a descent, from south to north. These observations are therefore inconsistent with such explanation of the cause of this lake; but they appear to prove that its northern barrier was the receding continental glacier. All the differences of the once level lines of lake Agassiz from our present level-line would be produced by the gravitation of the water of the lake toward this ice-sheet. At first this attraction had a large effect upon the lake-level because of the nearness of a great depth of ice on the east, in northern Minnesota and northward in British America, but it was gradually diminished to a comparatively small influence when these ice-masses had been melted and the attracting force proceeded from the region far north between lake Winnipeg and Hudson bay.

In the same way the ocean during the glacial period was drawn toward the ice-sheet, so that northward it stood higher than now, as shown by its recent deposits along our northern coasts, far above the present sea-shore. It appears that the form of the surface of the continent during the ice age was about the same as it is to-day; but that the sea-level was much changed by the great accumulations of ice, being drawn toward them by gravitation and thus raised higher than now toward the poles, while it was proportionately lowered about the equator.

AREA AND DEPTH OF LAKE AGASSIZ.

The upper beach of lake Agassiz, as here described from lake Traverse and Herman north to Maple lake, extends through a prairie region, very favorable for exploration and leveling. Its farther course turns to the east and northeast and lies in a trackless forest, much of which consists of almost impassable tamarack swamps. It is therefore quite impracticable to trace its course exactly through this wilderness; but from the known elevation of Red lake, 1140 or 1150 feet, very nearly, above the sea, of the lake of the Woods, 1042, and of Rainy lake, about 1175, the outline of lake Agassiz when it had its greatest hight can be mapped approximately.

From the north side of Maple lake it first extends east sixty miles, passing south of Red lake. Next this shore of lake Agassiz turns northward east of Red lake, beyond which it again runs eastward, crossing the Big fork of Rainy Lake river, and extends along the south side of Rainy lake, its hight above Red and Rainy lakes being probably between 50 and 100 feet. Thus lake Agassiz at this time of greatest hight reached along our northern boundary beyond the meridians of Minneapolis and Saint Paul. Its expanse included no islands, excepting rarely one of small area close to its shore.

When this glacial lake attained its greatest extent, just before it found an outlet into Hudson bay over the melting ice-sheet, its length from south to north was probably greater than the length of lake Superior; but its area was only half or two-thirds that of lake Superior, because of its less average width.

At the time of the formation of its highest beach, the depth of lake Agassiz above the lake of the Woods was some 200 feet; above the Red river valley at our northern boundary, 450 feet; and above lake Winnipeg, about 600 feet.

LETTER.

CHEMICAL LABORATORY, HAMILTON COLLEGE,
CLINTON, ONEIDA COUNTY, N. Y., July 11, 1883.

Prof. N. H. Winchell:

MY DEAR SIR, — I enclose herewith my long delayed paper on your Minnesota Iron Districts. The delay, however, has not been through any neglect of mine, but because I could not, until recently, persuade the owners to allow me to make the facts public. I now send you a complete statement, which I hope you will consider of some value to your work. Every analysis given was made here by myself, personally, and I will answer for the correctness of all the chemical work. The story might perhaps be made stronger for Vermilion, but it is strong enough as I put it.

Very sincerely yours,

ALBERT H. CHESTER, E. M., Ph. D.
Prof. of Chemistry and Mineralogy.

V.

THE IRON REGION OF NORTHERN MINNESOTA.

BY ALBERT H. CHESTER.

There are two extensive iron districts in northern Minnesota, known respectively as the Mesabi Iron Range, in Town 59, Range 14 W. and Town 60, Ranges 12 and 13 W., and the Vermilion Iron District, in Town 62, Range 15 W. These districts are about twenty miles apart. Within a few years both have been very carefully explored to ascertain the extent and value of the ore deposits. Before these explorations were undertaken all knowledge of this region, inhabitated only by Indians, was obtained from the explorers and timber hunters who had run over it in the pursuit of their calling, and from those who had visited Vermilion lake during the gold excitement of 1866. Little attention was paid to iron at that time however, though some samples of the hematite from T. 62, R. 15, were sent with the so-called gold ores to be exhibited with other ores from Minnesota at the Paris Exposition of 1867. The pieces sent were large and handsome samples of nearly pure, hard, specular iron, and it is strange that they did not attract more attention. In May, 1867, the Smithsonian Institution distributed boxes of mineral specimens to such academies as applied for them. No. 5021 of the list of minerals sent is labelled "Hematite, Vermilion lake, Minn." As these were fair sized cabinet specimens, and a hundred or more of the boxes were sent out, a considerable quantity of the ore must have been brought down in 1866, to furnish the material used. It was not however until 1875 that the Mesabi district was explored, and Vermilion received little attention as an iron district until the expedition of 1880. It is the object of this paper to give in detail the results of these expeditions.

THE MESABI IRON RANGE.

To reach this district the old government road to Vermilion lake was followed as far as the Embarras bridge. From this point a new road was cut out, striking T. 59, R. 14 in the southwest quarter of section 31. Before reaching this township evidences of what is to appear are seen in the decided disturbance of the compass needle, and the occasional pieces of magnetite in the drift. Some of these are of considerable size and cause so much variation of the needle as readily to lead an observer to suppose that ore bodies of magnitude were near at hand. No ore in place was found, however, until section twenty-eight was reached, where, in the southwest of the northwest quarter the ledge was exposed by sinking to a depth of eighteen feet, and the rock found to be magnetitic quartzyte similar to that described below, and too poor to be called ore or to deserve farther attention.

In the northwest of the northwest quarter of section fourteen considerable excavations were made to ascertain the nature of the deposit, there being a decided outcrop of magnetite. The rock strata throughout the district lie nearly horizontal, and the beds of ore are intercalated with the everywhere abundant quartzyte. The slight dip here is to the south, as is usual throughout the district. A perpendicular face of about fourteen feet was exposed and was found to consist of layers of mixed quartzyte and ore. A sample from the best layers, aggregating four and a half inches in thickness, was taken for analysis, and showed 48.47 per cent. of iron.

About a half mile east of this point, in the same quarter-section, ore shows on the surface for a length of thirty feet. Here a pit was sunk cutting the strata at right angles. At the top three feet of white quartzyte was found. Underneath this lie six feet of mixed magnetite and quartzyte. At this depth a layer of ore comes in a foot and a half thick, of which four inches at the middle is better than the rest and contains 53.45 per cent. of iron. For seven feet below this to the bottom of the pit the ore is very poor.

Near the center of section eleven there is a bold outcrop of jaspery hematite, at the foot of which a pit was sunk to considerable depth. At fifteen feet from the surface a layer of black sand was found containing boulders of quite pure hematite. An average sample from these boulders showed 62.17 per cent. of iron, almost the richest ore discovered in the district. Careful search failed to find the ledge from which these boulders came, and they seemed a novelty in a district covered with horizontal layers of magnetite and quartzyte.

The next exposure of ore was found near the center of section 24, T. 60, R. 13. The best ore found here was a layer on the top about two and a half inches in thickness and containing about 60 per cent. of iron. A pit was sunk to a depth of thirteen feet but nothing was found as good as that on the surface.

In the northwest quarter of section 20, T. 60, R. 12 W., the most important of the workings of Mr. Peter Mitchell, the first explorer of the Range, was found. This was a pit six feet in depth, and from it was said to have been obtained the best ore he brought back. This old pit was cleaned out and sunk to a depth of 11.2 feet. The stratification on one side of the pit was as follows :

3.0	feet,	surface soil, sand and gravel.	
0.4	"	ore,	sampled.
0.7	"	poor ore,	
0.5	"	ore,	"
0.6	"	medium ore,	
0.2	"	ore,	"
0.6	"	"	"
2.0	"	poor ore,	"
0.2	"	ore,	
0.6	"	poor ore and quartzyte,	
1.3	"	ore,	"
0.6	"	"	"

As mentioned above, this represents only one side of the pit, the changes from magnetite to quartzyte being so abrupt that the layers of ore can seldom be followed for any distance. The total thickness of ore shown here is about three and a half feet and the sample made from all the best layers gave 44.10 per cent. of iron. Selected samples from this place previously brought out by Mr. Mitchell gave on analysis the following results:

	1	2	3	4	5
Metallic iron	52.67	57.95	53.51	56.76	56.88
Silica	22.22	11.37			
Alumina		2.84			
Lime	0.22	1.53			
Magnesia	1.61	3.33			
Manganese oxide		1.32			
Sulphur	trace.	0.06			
Phosphorus		trace.			
Oxygen with iron		22.08			
Total		100.48			

These analyses were made by the writer previous to the expedition, and from samples furnished by the owners of the property. The magnetic character of these samples was very noticeable, some very fine lodestones having been found among them. This is a prominent characteristic of all the best ore of the district.

Another of Mitchell's old workings was found on the line between sections 18 and 19, in the same town. This was continued until a total depth of fourteen feet was attained. About four and a half feet of good ore was found at this place, an average sample showing 52.82 per cent. of iron.

In the northeast quarter of section 17, T. 60, R. 12, a ledge was discovered which, after having the talus at the base cleared away, exposed the stratification for a hight of twenty-five feet as follows :

0.2	feet	best ore.
1.5	"	good ore.
.25	"	ore mixed with quartzyte.
0.2	"	good ore.
10.6	"	poor ore and quartzyte.
10.0	"	quartzyte with some ore,

The whole amount of good ore here shown is less than two feet, the best being at the very top of the cliff and showing 62.37 per cent. of iron. Clearing off the moss on the level ground at the top, the whole surface for some distance is shown to be of this layer, smoothed and polished by glacial action, and as one walks over it he seems to be walking on solid iron. The deposit at this place is of sufficient extent to give color to the story of "a mountain of iron, larger and richer than the famous Iron mountain of Missouri." But when the surface is carefully examined it is seen to have a mottled or marbled appearance in consequence of the constant changes between the magnetite and quartzyte. No layer can here be followed any distance without showing this change. This lack of uniformity is one of the most noticeable features of these deposits.

In the northwest quarter of section 20, an outcrop of the ore is seen in the bed of a small brook. A layer of about six inches in thickness and of considerable permanence can here be followed for nearly a quarter of a mile. The dip of the stratum is to the south at the rate of about six feet in every one hundred. An average sample of this ore shows 57.12 per cent. of iron.

A sample was made from all the specimens brought back which showed by analysis 44.68 per cent. of metallic iron. It was extremely difficult to take fair samples of the ore on account of the continual changes in the character of the layers, but so large a number of specimens were selected, covering so great an extent of territory, that this is believed to be a fair representation of the richness of the ore in the district, above the level of the swamp water. All the pits were sunk to this level, and work was stopped only when the water came in so rapidly that further work was impossible without pumping.

A ledge of quartz containing galena should be mentioned here, which was found in the southeast quarter of section 11, township 59, range 14. This vein of quartz dipping 78° to the southeast and cutting through the horizontal beds of quartzyte has a very interesting appearance, and from the galena it shows was at once called a silver mine by the miners. But careful assays of the ore obtained failed to reveal any trace of the precious metal, and the amount of galena is too trifling to make it of value as a lead ore.

The quartzyte so often mentioned here is a greyish colored quartz-schist often slaty and arenaceous, and generally more or less impregnated with magnetite, though sometimes free from it. Even the strata that are richest in iron show plainly this mode of formation. A sample of this magnetitic schist, which well illustrates the whole, examined under the microscope by polarized light, showed areas of nearly pure magnetite with some hornblende and quartz, in which were minute crystals of apatite.

These magnetitic schists are terminated on the north by a red or pink granite which constitutes the backbone of the Mesabi range. The nearly horizontal schists abut against this backbone, which rises abruptly in some places to a considerable hight.

The granite was not examined under the microscope but appeared to the eye to be much the same as the one described further on, and which forms the divide between the waters flowing north and those running south. It is probable that the Mesabi range originally formed this divide; but now the Embarras river has broken through it, and discharges into the Saint Louis river and thence into lake Superior.

The schists and slates of the Mesabi district dip in general toward the south, but never at an angle of more than two or three degrees from the horizontal, the dip changing a little from point to point so as to present the appearance of a slightly undulating surface. In all respects except this horizontal bedding the Mesabi district is precisely similar to the Penokee region of Wisconsin, and a person familiar with the latter cannot fail to notice the close resemblance. Here are the same magnetitic schists, hornblendic magnetitic schists, dark and light grey quartz schists, arenaceous grey and white quartzytes, and other similar rocks; and especially, here is the same apparent substitution of quartzyte and magnetite for each other. The writer pointed out this resemblance in his report on the Mesabi district, presented in 1875, and is now clearly of the opinion that the iron-bearing rocks of this district bear the same relation to the Huronian series as do the rocks of the Penokee Iron range in Wisconsin.

On the north side of the Mesabi ridge the rock strata are much more inclined and consist of similar slates and quartzytes, but without the magnetite. The general trend is east and west following the line of the ridge. There is a second belt of red granite, the one alluded to above, exposed on the long portage between the Embarras and Pike rivers, in the southwestern part of T. 60, R. 15 W., which is identical in appearance with that of the Mesabi backbone. This is a medium grained, flesh red or pink hornblende-granite, in which the crystals of feldspar are sometimes porphyritically developed, and show twinning of the Carlsbad type. Under the microscope it presents the following characteristics. Microcline, oligoclase and orthoclase are the principal ingredients, named in order of abundance. Quartz is very plenty and also common green highly dichroic hornblende. Magnetite and ferrite occur as accessories.

In descending the Pike river but little rock was found in place, but at one of the rapids in the south part of T. 61, R. 16, there is a considerable exposure of a blackish schist, the beds being nearly perpendicular, dipping however slightly to the south. The trend of these beds is similar to that of the rocks found in connection with the iron further north. These are hornblendic biotite-schists, minutely crystalline, of dark grey color, schistose in structure, and pyritiferous. Under the microscope there is seen a quartz groundmass of very fine particles; biotite in minute scales; hornblende, next in abundance, and rather plentifully distributed through the rock in relatively good sized crystals. Porphyritic quartzes are also seen with quite distinct crystalline outlines; as accessories pyrite and ferrite are seen. This is at once recognized as a typical Huronian schist.

THE VERMILION LAKE IRON DISTRICT.

At the time of the explorations in the Mesabi Iron range in 1875, attention was called to the iron near Vermilion lake, and some preliminary exploration was made there. Although the full extent of the deposit was not discovered, enough was seen to warrant a favorable report, and many samples were brought back and analyzed with results as follows:

	1.	2.	3.	4.
Metallic iron	64.25.	67.77.	65.19.	63.26.
Silica				7.57.
Alumina				1.89.
Phosphorus				trace.
Sulphur				0.05.
Oxygen with iron				27.11.
Total				99 88

These samples were obtained from what was afterwards ascertained to be T. 62, R. 15 W., No. 1 being from section 27, No. 2 from section 28, No. 3 from section 33, and No. 4, an average of all the samples obtained. On account of the depression in the iron market nothing further was done in the matter until 1880, when an exhaustive examination of the whole district was made.

The belt of iron ore is well defined where exposed, and numerous trenches were made to show it where it was covered up with the superficial layer. The ore is found as usual in connection with jasper and quartzyte, and in many cases presents well defined walls of slate. It is intimately bedded with the rocks of the country, and stands so nearly perpendicular that it was difficult to ascertain the true dip, but as the result of many observations it was thought to incline slightly to the south. The trend is generally east and west, though this varies from point to point. The rock strata are very much folded and contorted showing evidence of great geological disturbance. The topography of the country resembles in a marked degree other Huronian iron regions, the general characteristics being low hills, and short ridges without regularity, separated by swamps and small lakes. Often the rock ledges are exposed, sometimes forming perpendicular cliffs, and these have served to determine the general details of the surface; but there are masses of earth and gravel in many places, which modify and alter the topography to a considerable extent, some of the ridges being entirely composed of such material. The evidence of glacial action is also very marked, the rocks being worn and polished in many places, the grooves and striations having the general direction S. 10° W. The prevailing rocks are the slates and schists found in other Huronian areas in connection with iron ore beds.

As developed by the exploration there seem to be two principal deposits of ore, running nearly east and west, and about a mile apart. The more northern one, nearest the lake, and upon which are located the Stone, Tower, Stuntz and Ely mines of the Minnesota Iron Co., has a total length of nearly a mile, continuing from the eastern part of section 28, nearly across section 27. The outcrop was seen on the surface in many places, and by trenching the whole width of the bed was exposed wherever practicable, until the fact was demonstrated that the deposit is one of great magnitude, rivaling those of Marquette and Menominee. The following table shows the width of ore on the surface, the average per cent. of iron in samples taken all across the bed without any sorting, and the character of the ore at the various places.

Mark.	Width of bed.	Per cent. of iron.	Character.
1	30 feet.	59.98	Bright, hard, specular.
2	30 "	54.29	"
3	38 "	56.45	"
4	35 "	59.58	Soft hematite.
5	16 "		"
6	18 "		"
7	25 "	58 21	Bright, hard, specular.
8	16 "		"
9	17 "	60.47	"
10	44 "	61.84	"
11	10 "		"
12	10 "		"
13	15 "		"
14	58 "	59.87	"
15	10 "		"
16	10 "		"
17	30 "	50.27	"
18	11 "		"

At some of these points the ore is very pure and free from admixture of rock, and needs little sorting. At others there are several seams of slate and jasper included in the sample, which would be sorted out in actual mining operations.

A description of one of these exposures will show the great similarity of the deposits to those of northern Michigan. At the one marked 3, for instance, the cross section is as follows, beginning at the North side:

6 feet, ore.
10 feet, ferruginous slate.
7 feet, ore.
8 feet, slate.

6 feet, jaspery ore.
18 feet, ore
20 feet, lean ore.
13 feet, brownish talcose schist.
22 feet, banded jasper.
7 feet, ferruginous slate.

The swamp water prevented further exploration at either end.

At 9 the ridge is abruptly terminated by a cliff of the presnt, brightest and hardest, steely looking ore, making the finest display in the district. The walls of the ore deposit are here clearly marked, being slate on the south and jasper on the north side. The end of the ridge was found completely covered with huge blocks of pure ore for a distance of 100 feet, which had been broken off and thrown down by the elements.

An average sample made from all the specimens taken from this belt was analyzed with the following results :

Silica,	5.55	per cent.
Iron,	58.31	"
Alumina,	9.96	"
Lime,	0 55	"
Manganese oxide,	0.20	"
Sulphur,	0.14	"
Phosphorus,	0.065	"
Oxygen,	25.08	"
Total	99.855	"

This percentage of iron is very high when we consider that all seams of quartz, jasper and slate occuring in the beds were included in the sample. Analysis of a sample picked from the richer pieces, carefully excluding all that showed any rock, showed 69.17 per cent. of iron.

The other principal deposit of the district is in section 33, where the exposures can be followed for a distance of nearly half a mile. The general description given above will suffice for this deposit, though the widest surface exposure is found here. At one place the writer walked forty steps across the outcrop of the bed which stands as before nearly perpendicular. An average sample for a width of 120 feet, gave 57.04 per cent. of iron. The following table shows some of the measurements and percentages :

Mark.	Width of bed.	Per cent of iron.	Character.
19	26 "	54.88	Hard specular.
20	18 "		"
21	5 "	62.82	"
22	120 "	57.04	"
23	14 "	52.43	"
24	26 "	54.70	"
25	18 "		"

The ore of this deposit is more streaked with white quartz than that of the other belt, and consequently does not show so high a percentage of iron. A partial analysis of an average from all the samples obtained from here gave the following results.

Silica	11.63
Iron	55.86
Sulphur	trace
Phosphorus	0.034

The percentage of phosphorus is, however, very small, making it a true Bessemer ore, and it can easily be sorted to high grade. A sample of sorted ore was made from each deposit and analyzed with results as follows:

	1	2
Silica	3.39	3.89
Iron	66 93	66.43
Alumina	0.74	0.85
Lime	0.08	trace
Phosphorus	0.011	0.006
Sulphur	0.01	none
Oxygen	28.695	28.477
Total	99.856	99.653

No. 1 is from the northern belt, and No. 2 from the southern.

It seemed desirable to ascertain the geological relations of the rocks of this district, and rock samples were carefully taken, many of which were subjected to examination in thin section under the microscope by polarized light. The most common rock of the region, and the ore in which the quartz veins formerly worked for gold are found, is a sericitic quartz-schist. It is aphanitic, dark-gray in color, not very hard, and with a sharp-edged fracture. Not thinly schistose, and effervesces in acids. Under the microscope it is an excessively fine-grained rock, with a ground-mass of minute quartz particles. There is a felt-like mass of sericite fibres all through the ground-mass, which are very close together and run in a common direction, but are more or less interwoven. Numerous particles of calcite are seen, and some magnetite.

A series of samples from the south of the ore, represents a highly altered mica schist, with sericite prevailing in the ground-mass. Porphyritic quartzes and fine quartz crystals are often seen in the ground-mass. Some of the sections show an abundance of chlorite. Hematite, limonite and magnetite are present as accessories, some specimens being red-stained by the iron. There are also some peculiar aggregations of brownish and blackish particles which may represent some original constituent, possibly andalusite or staurolite.

The samples of slates intercalated with the ore were found to be the same sericite schists, but more completely replaced by iron oxide, which reddens and permeates the rocks. In some cases this replacement is so complete as to constitute beds of soft hematite.

The rocks north of the ore, between it and the lake, are mostly these same schists but not so much altered. Some of the specimens are still dark colored, and not much altered. Others are a mere clay. Banded jasper is also found in abundance, and also something closely resembling novaculite. A very siliceous limestone is found in many places exactly similar to one common in the Huronian of Michigan and Wisconsin. Its best development at Vermilion is at Ely island.

At one point in the eastern part of section 27, there is a break in the continuity of the ore deposit where a small stream runs south into the swampy ground south of the ore. On the east side of the small ravine caused by the stream, the ore is in place, showing a width of 30 feet, but on the west side it was not found. Every change in the rocks was carefully noted and samples were taken throughout the length of the ravine, crossing the line of the ore and continuing several hundred feet south of it, and north of it to the lake. The rocks were found to be largely the same sericite schists, showing under the microscope folia of sericite, and quartz, in the ground-mass; porphyritic quartzes with crystalline outlines; brown opaque particles as before; and chlorite. Some are magnetitic quartz-schists exactly similar to those of Mesabi. One section in particular shows a ground-mass of minute closely fitting angular quartz particles composing most of the rock. Magnetite is abundant in this specimen, in many square and rhombic sections. The red color of some of them is due to the presence of red oxide of iron. Particles of specular hematite are also seen. As at Mesabi there is a small quantity of hornblende. Besides these sericitic and magnetitic schists, and the banded jasper and specular iron. very fine granular quartzytes were found. In one specimen of this kind there was seen quartz in very close-fitting angular particles, composing most of the rock; magnetite in minute particles, often distinctly outlined, and films of real oxide of iron among the particles of quartz. Some altered quartziferous porphyries were also found near the lake. These are of a grayish color and much weathered. They are aphanitic, non-schistose and with porphyritic glassy quartz crystals. Under the microscope they show the characteristics of altered porphyries, the ground mass being largely kaolinized, though the original felsitic character can still be clearly made out. Another quartzyte found in section 22 in considerable masses is white and granular. Under the microscope it exhibits large quartz and feldspar particles, buried in a matrix of the same materials, and may be of fragmental origin.

The above describes all the varieties of rock collected in the town where the iron is found. The next town east, T. 62, R. 14 W., was carefully looked over for the continuation of the ore deposit, but it was not found. This town is very much cut up with small lakes and swamps, but many rock exposures were found and samples taken, particularly from sections 9, 11, 15, 16, 17 and 19. Those brought back consisted of light colored granite, aphanitic dark grey slate, black aphanitic quartz-magnetite schists, the amount of magnetite varying in different specimens, sericitic quartz-schists, jaspery rocks, and fine-grained quartzytes. One of the latter appears as follows under the microscope. Quartz in fine particles which are angular and interlocked; magnetite and red oxide of iron in patches, and pyrite, while veins filled with chlorite and epidote intersect the specimen.

In section 2 of the same town about three miles north of the line of the ore beds, rocks of a very different character are found. They are more chloritic, of a decidedly greenish color, and schistose in character. There are also greenish aphanitic slates and banded magnetitic cherts, resembling in every particular the Laurentian rocks found in connection with the iron-bearing Huronian rocks of the south shore. In T. 63, R. 13, similar rocks were found which bear a very close resemblance to the Laurentian rocks just mentioned, one being a greenish aphanitic schist, and another a medium grained, dark greenish semi-schistose and highly crystalline rock. Another is seen under the microscope to be a dioryte, consisting of hornblende and oligoclase as the only important constituents, and in nearly equal proportions. The hornblende is in large ragged-edged green sections, while some of the feldspars are much altered. There is some epidote as an alteration result, in clusters of round grains, with apatite and magnetite in minute quantity.

Besides a careful examination of the iron-bearing rocks, the so-called gold deposits were looked over. Specimens were collected from many quartz veins, on some of which mines were formerly located, and all were carefully assayed. It is hardly necessary to say that not a trace of gold was discovered. No true iron pyrites was found, but all was of that form known as pyrohotine, or magnetic pyrites. Among the many samples of pyrites, from all parts of the country, assayed for gold at the laboratory of Hamilton College, not one containing magnetic pyrites has shown any gold, and so-called gold mines have been condemned at once when the character of the pyrites was recognized, subsequent assay always corroborating the opinion. It was therefore not a matter of surprise that these "gold ores" did not contain any gold.

A careful study of the region above described, and of the rocks and ores brought out, forces on the writer the conviction that this deposit of iron is the representative on the north shore, of the Michigan and Wisconsin iron deposits. There can be no doubt that the regions described belong to the Huronian. The rocks are many of them typical Huronian rocks, and the whole Mesabi district presents such a strong likeness to the Penokee in all particulars as to make its identity indisputable. That the Vermilion deposits are simply a continuation of the same formation seems also to be a fact. The intricate foldings of the strata account for their vertical position, and the rocks are so nearly like those of Mesabi and bear such similar relations to the Laurentian granites and slates, as to convince one of their identity. The peculiar replacement of the schists by red oxide of iron, forming beds of soft hematite entirely similar to certain deposits found at Marquette, and the very siliceous limestone common in this region, and similar in character as well as in mode of occurrence to beds found in Marquette, Penokee and Menominee, are facts with a plain signification.

The geological similarity of the Vermilion iron deposits to those of Marquette, is the impressive fact to be noticed by the people of Minnesota, and it is safe to predict the development there of an iron district of immense value and importance.

This paper should not be closed without an expression of thanks to professor Roland D. Irving, of Madison, Wis., to whom all the rocks were sent to be examined, and whose notes on these examinations were placed freely at the service of the writer. Thanks are also due to Mr. George C. Stone, of St. Paul, General Manager of the Minnesota Iron Co., who planned the expeditions, and aided in every way to their successful completion; and to the veteran surveyor, explorer and geologist, Mr. George R. Stuntz, whose experience in all these lines was invaluable.

Hamilton College, July 11th, 1883.

VI.

NOTE ON THE AGE OF THE ROCKS OF THE MESABI AND VERMILION IRON DISTRICTS.

BY N. H. WINCHELL.

In the report for 1878 (p. 10) the rocks of the iron-bearing belts of Vermilion lake and of the Mesabi range were parallelized with the Gunflint beds of the northern boundary, the latter being the lowest portion of the great slate-and-quartzyte group which had before been designated the Animikie group by Dr. T. Sterry Hunt.

In the report for 1880 (p. 81) the Gunflint beds are stated to be a graduation downward of the slate-and-quartzyte group; and in the same report (p. 82) the slate-and-quartzyte group is described as overlying unconformably (apparently) another formation made up of greenish schists, entirely a distinct formation, the two being separated by a conglomerate or conglomerate-breccia, the lower formation being supposed to be that which has been styled the Huronian by the Canadian geologists. This greenish magnesian schistose formation is traced, through some variation, westward along the strike of the formation as far as the east end of Basswood lake and to the Pipestone rapids (p. 91), one of its chief localities being at the mouth of the Kawasachong river. It perhaps extends to Vermilion lake (p. 95), and occupies the central portion of the lake, including Ely island. But the rocks at the south end of the lake are apparently of the slate-and-quartzyte group, which here exhibits a true slaty structure (p. 97, Nos. 389–394); while those at the north end consist of a mica-schist, embracing lenticular masses of granite (p. 100.) In the same report the iron ore of the Vermilion lake district is stated to be in the horizon of the Gunflint beds, and to lie directly on the foregoing supposed Huronian schists. (p. 103-4.)

In the report for 1881 (p. 95) various considerations are mentioned that go to show that the slate-and-quartzyte group of the northern boundary becomes the tilted slates and gray quartzytes of Ogishke Muncie lake, and of the region of Thomson on the St. Louis river; and also that there is a red granite overlying the slate-and-quartzyte group north from Grand Marais (pp.74-79), as well as in the region south from Ogishke Muncie lake (pp. 99-102.) In the same report the slate-and-quartzyte group (the Animikie) is parallelized with the Taconic group of professor Emmons (p. 135).

In the geological reports of Wisconsin, issued recently by professor Chamberlin, the rocks of the Penokee iron range have been classed as Huronian by professor Irving (*Geol. of Wis.*, vol. iii.; p. 104.) The same reports have referred the Thomson slates and quartzytes of Minnesota to the Huronian (vol. iii., plate IX.), as well as the red quartzytes and felsytes of central Wisconsin. Professor Irving has also, more lately, stated unqualifiedly and without reserve that the Animikie rocks of the northern boundary are Huronian. (*Science*, May 4, 1883.)

In Michigan, major Brooks has placed the Marquette iron-bearing rocks in the Huronian (*Geol. Sur. of Mich.*, vol. i.; p. 66) and has described (Table iii., *Geol. of Wis.*, vol. iii.; p. 450) the "newest Huronian," as consisting of a red granite; and Dr. C. Rominger has described a conversion from horizontal slates to tilted slates, similar to that above referred to as probable in Minnesota, the two having been regarded before as different.

Quite recently Dr. T. S. Hunt, in a paper on the *Taconic question in geology*, published in the *Transactions of the Royal Society of Canada*, has not only maintained the Taconic age of the Animikie rocks but has adopted their supposed conversion into the tilted slates and quartzytes suggested by the writer in 1881, and extends them southwestward to Thomson on the St. Louis river, where he states that by the aid of Dr. J. W. Dawson he has discovered a fossil keratose sponge in some dark calcareous concretions.

If all these facts and opinions be brought to bear on the interpretation of the stratigraphy of northern Minnesota, while they cannot all be reconciled so as to make perfect harmony, the most probable result, in the opinion of the writer, would be as follows, in descending order:

Potsdam formation.	Tilted red sandstones, shales and conglomerates, changed by igneous gabbros and dolerytes locally to red quartzytes, felsytes, quartz-porphyries and to red granite. The Keweenian, and the Huronian in part, in Wisconsin.
Taconic group.	Horizontal black slates and gray quartzytes, with interbedded limestones and diorytes (the Animikie group,) changed to tilted slates, quartzytes, iron ores, and siliceous marble. The Gunflint beds, the Mesabi iron rocks, the Ogishke Muncie conglomerate (?), the Thomson slates and quartzytes, the Vermilion iron rocks;—the Huronian in part, in Wisconsin and Michigan.
Huronian group?	Magnesian, greenish, soft schists, becoming syenitic and porphyritic. Seen on the north side of Gunflint lake, along the international boundary at Basswood lake, and at Vermilion lake. The Huronian in part, in Wisconsin and Michigan.
Montalban?	Mica schists, and micaceous granite, the latter lenticular within the former, at the outlet of Vermilion lake—probably also at "Granite City" in Morrison county, and at Pike rapids on the Mississippi. The Huronian in part, in Wisconsin and Michigan.
Laurentian.	Massive hornblende gneiss, gray to nearly white, rarely reddish. The international boundary north of Gunflint lake to Saganaga lake and westward; also probably the Watab and Saint Cloud "granites."

VII.

CHEMICAL ANALYSES.

REPORT OF PROF. J. A. DODGE.

CHEMICAL LABORATORY, UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, Nov 28, 1883.

Prof. N. H. Winchell:

DEAR SIR: I herewith report the following analyses of minerals and waters for the geological survey.

Chem. series, No. 84. A dark brown rock, with fossils, and a concretionary appearance. This was tested at your request, for phosphoric acid. No phosphoric acid was found.

Chem. series, No. 85. A reddish concretionary mineral, in small lumps, appearing like a zeolite. The sample taken for analysis was selected, after partly breaking up the lumps, so as to be as homogeneous as possible. Its composition was as follows:

			Oxygen.		Oxygen ratios.
Silica,	62.73	per cent.	33.45		14.61
Alumina,	13.62	“ “	6.35	6.87	3.00
Oxide of iron,	1.75	“ “	.52		
Lime,	5.87	“ “	1.67	2.52	1.10
Magnesia,	0.65	“ “	.26		
Soda,	1.83	“ “	.48		
Potash,	0.68	“ “	.11		
Water	12.25	“ “	10.89		4.71
	99.38				

The composition seems to bring this mineral under the species *mordenite.*

Chem. series, No. 86. A nearly white, concretionary, zeolitic mineral. Composition as follows:

			Oxygen.		Oxygen ratios.
Silica,	47.25	per cent.	25.19		6.47
Alumina,	24.78	" "	11.54	11.68	3.00
Oxide of iron,	0.48	" "	.14		
Lime,	1.23	" "	.35	4.52	1.16
Magnesia,	0.71	" "	.28		
Soda,	15.05	" "	3.19		
Potash,	traces.	" "			
Water,	10.37	" "	9.22		2.37
	99.87				

The composition seems to refer this mineral to the species *natrolite.*

ANALYSES OF A SERIES OF WATERS.

Chem. series, No. 126. Analysis of water from the Red river of the North at St. Vincent, collected June 10th, 1882; analyzed in first part of September, 1882, having been in the mean time kept in glass bottles.

Composition of residue from evaporation.

	Parts to 1,000,000.	Percentage.	Grains per gallon.
ilica,	13.0	4.6	0.75829
Oxide of iron and alumina,	1.0	.4	0.05833
Carbonate of lime,	97.8	34.3	5.70467
Sulphate of lime,	35.7	12.6	2.08238
Nitrate of lime,	1.1	.4	0.06416
Carbonate of magnesia,	81.9	28.7	4.77723
Phosphate of lithia,	.6	.2	0.03499
Sulphate of potash,	8.7	3.1	0.50747
Nitrite of potash,	traces.		
Bromide of potassium,	traces.		
Sulphate of soda,	21.7	7.6	1.26576
Chloride of sodium,	22.9	8.1	1.33576
	284.4	100.0	16.58904

Iodine was found to be absent. A test for organic matter was made by the permanganate method (Tidy's). The oxygen required for oxidation was 3.5 per million. The hardness was found to be 19 degrees of Wanklyn's scale. The water is notable for its hardness, owing to the sulphate of lime and the carbonates.

The above analysis was made by Wm. A. Noyes.

Chemical series, *No. 127.* Analysis of water from the Red river of the North at Fergus Falls; collected in June, 1882, analyzed in Sept., 1882.

Composition of residue from evaporation.

	Parts to 1,000,000.	Percentage.	Grains per gal.
Silica,	14.3	7.0	0.83412
Alumina and oxide of iron,	1.2	.6	0.06999
Carbonate of lime,	101.0	50.0	5.89133
Carbonate of magnesia,	71.4	35.4	4.16476
Carbonote of lithia,	traces.		
Carbonate of potash,	4.2	2.1	0.24919
Bromide of potassium,	traces.		
Nitrate of potash,	traces.		
Nitrite of potash,	traces.		
Carbonate of soda,	5.8	2.8	0.33831
Sulphate of soda,	1.8	.9	0.10499
Chloride of sodium,	2.3	1.2	0.13456
Total,	202.0	100.0	11.78725

Iodine, absent; phosphoric acid, traces. Test with permanganate (Tidy's), showed 1.4 parts oxygen consumed by organic matter per million parts water. The hardness was found to be 9.5 degrees.

Analyzed by Wm. A. Noyes.

Chemical series No. 128. Analysis of water from Heron lake; collected in June, 1882; analyzed in Sept., 1882.

Composition of residue from evaporation.

	Parts per 1,000,000.	Percentage.	Grains per gal.
Silica,	7.1	2.6	0.41414
Alumina and oxide of iron,	1.7	.6	0.09916
Carbonate of lime,	102.7	37.7	5.99049
Sulphate of lime,	47.9	17.6	2.79241
Nitrate of lime,	5.0	1.8	0.29165
Carbonate of magnesia,	76.3	28.0	4.45058
Carbonate of lithia,	traces		
Sulphate of potash,	8.0	3.0	0.46664
Nitrite of potash,	traces		
Sulphate of soda,	18.5	6.8	1.07911
Chloride of sodium,	5.1	1.9	0.29748
Total,	272.3	100.0	15.88166

Iodine, absent; bromine, absent; phosphoric acid, absent.

Test with permanganate showed 2.6 parts oxygen consumed by organic matter per 1,000,000 water.

Hardness, 22 degrees. The water is notable for excessive hardness, due to sulphate of lime and carbonates of lime and magnesia.

Analysis by Wm. A. Noyes.

Chem. series, No. 129. Analysis of water from Pigeon river falls ; collected in Aug., 1882 ; analyzed in Sept., 1882.

Composition of residue from evaporation.

	Parts per 1,000,000	Percentage.	Grains per gal.
Silica,	7.2	14.2	0.41998
Alumina and oxide of iron,	.8	1.6	0.04666
Carbonate of lime,	23.0	45.2	1.34159
Carbonate of magnesia,	10.2	20.0	0.59497
Carbonate of lithia,	traces		
Carbonate of potash,	.7	1.4	0.04083
Nitrate of potash,	traces		
Sulphate of potash,	2.0	3.9	0.11666
Sulphate of soda,	1.9	3.7	0.10923
Chloride of sodium,	5.1	10.0	0.29748
	50.9		2.96740

Iodine and bromine, absent; nitrites, absent; phosphates, absent; borates, absent.

Test with permanganate showed 3.6 parts oxygen consumed by organic matter per 1,000,000 water.

Hardness, 3.3 degrees. The degree of hardness is low.

Analysis by Wm. A. Noyes.

Chem. series, No. 130. Analysis of water from lake Superior at Grand Marais ; collected and analyzed in Sept., 1882.

Composition of residue from evaporation.

	Parts per 1,000,000.	Percentage.	Grains per gal.
Silica,	.5	1.1	0.02917
Alumina and oxide of iron,	traces.		
Carbonate of lime,	30.8	67.4	1.79656
Carbonate of magnesia,	9.1	19.9	0.53080
Carbonate of lithia,	traces.		
Carbonate of potash,	1.9	4.2	0.11083
Nitrate of potash,	.2	.5	0.01167
Nitrite of potash,	minute traces.		
Carbonate of soda,	.5	1.1	0.02917
Sulphate of soda,	.6	1.3	0.03499
Chloride of sodium,	2.1	4.5	0.12249
Total,	45.7	100.0	2.66568

Iodine and bromine, absent ; phosphates and borates, absent.

Test with permanganate showed 0.35 parts oxygen consumed by organic matter per 1,000,000 water.

Hardness 3.5 degrees.

The water is remarkable for its purity, especially organically.

Analysis by Wm. A. Noyes.

Chem. series, No. 131. Analysis of water of artesian well at Carman, Polk county, October, 1882.

Composition of residue from evaporation.

	Parts per 1,000,000.	Percentage.	Grains per gal.
Silica,	26.2	5.7	1.529
Alumina and oxide of iron,	1.5	.3	.087
Carbonate of lime,	88.6	19.4	5.171
Carbonate of magnesia,	52,9	11.6	3.087
Carbonate of lithia,	traces.		
Carbonate of potash,	11.5	2.5	.671
Nitrite of potash,	traces.		
Carbonate of soda,	73.8	16.2	4.308
Sulphate of Soda,	47.5	10.1	2,773
Borax,	traces.		
Chloride of sodium,	156.5	34.2	9.134
Bromide of potassium,	traces.		
Iodide of potassium,	traces.		
Total,	458.5	100.0	26.760

Nitrates, absent; phosphates, absent.

Test with permanganate showed 0.85 parts oxygen consumed by organic matter per 1,000,000 water.

Hardness, 12.5 degrees.

The water is remarkable for the large amounts of carbonate of soda and chloride of sodium.

Analysis by Wm. A. Noyes.

Chem. series, No. 132. Analysis of water from Minnesota City, October, 1882.

Composition of residue from evaporation.

	Parts per 1,000,000.	Percentage.	Grains per gal.
Silica,	16.3	5.2	0 .95078
Alumina and oxide of iron,	2.5	.8	0.14583
Carbonate of lime,	182.0	57.7	10.61606
Carbonate of magnesia,	104.3	33.0	6.08382
Carbonate of lithia,	traces.		
Carbonate of potash,	1.6	.5	0.09333
Sulphate of potash,	.7	.2	0.04083
Nitrite of potash,	traces.		
Sulphate of soda,	7.7	2.4	0.44914
Chloride of sodium,	.5	.2	0.02917
Total,	315.6	100.0	18.40896

Iodine and bromine, absent; phosphates, traces; borates, absent.

Hardness 11.5 degrees.

The sample of water whose analysis is above given, also contained sulphuretted hydrogen gas. A second sample received later gave no reaction for sulphuretted hydrogen.

Analysis by Wm. A. Noyes.

Chem. series, No. 133. Analysis of water from Rock river; collected and analyzed in November, 1882.

Composition of residue from evaporation.

	Parts per 1,000,000.	Percentage.	Grains per gal.
Silica,	21.0	7.6	1.22493
Alumina,	1.0	.4	0.05833
Oxide of iron.	8.8	3.2	0.51330
Carbonate of lime,	136.0	49.6	7.93288
Sulphate of lime,	6.4	2.3	0.37332
Nitrate of lime,	traces.		
Carbonate of magnesia,	70.4	25.7	4.10643
Phosphate of lithia,	minute traces.		
Sulphate of potash,	3.3	1.2	0.19249
Sulphate of soda,	25.6	9.3	1.49325
Chloride of sodium,	2.0	.7	0.11666
Total,	274.5	100.0	16.01158

Iodine and bromine, absent; phosphates, minute trace; borates, absent. Test by permanganate showed 1.1 parts oxygen consumed by organic matter per 1,000,000 water.

Hardness, 17 degrees.

The water is notable for the large amount of iron.

Analysis by Wm. A. Noyes.

Chemical series, No. 137. An oolitic substance of a brown color, evidently consisting largely of oxide of iron. On further examination it was found that this iron compound formed the superficial part of each granule in the mass, while the interior of each granule consisted of carbonate of lime. The substance was accordingly treated as follows. After pulverizing, it was treated with cold dilute hydrochloric acid, which removed the carbonate of lime. The remaining brown matter was washed and digested in strong hydrochloric acid; this treatment brought all into solution with the exception of some siliceous matter of a nearly white color. The amount of iron in this solution was determined. The amount of combined water in the brown matter was also determined. The results of these determinations are here given:

Siliceous matter....	10.56	per cent.
Oxide of iron......................	71.35	" "
Water.......	11.98	" "

The oxide of iron and the water are in the same ratio as in limonite, $2Fe_2O_3\ 3H_2O$. Hence it was concluded that the brown coating on the granules of the oolitic substance was limonite.

Work chiefly done by W. A. Noyes.

Chemical series, No. 138. A specimen of rock from Mankato, near the Red Jacket railroad bridge, as stated on label.

The sample was of a nearly white color and fine-grained, somewhat friable.

The result of the analysis is as follows :

Silica,	93.65	per	cent.
Alumina,	2.15	"	"
Oxide of iron	.25	"	"
Lime,	.20	"	"
Magnesia,	.12	"	"
Potassa,	traces.		
Soda,	traces.		
Water,	2.25	"	"
	98.62		

The analysis was made by Mr. C. F. Sidener.

The specimen, as indicated by the label, was furnished by J. G. Koller, of Mankato.

Chemical series, No. 139. A specimen of rock from the same locality as the last, furnished by J. G. Koller of Mankato.

The sample was of a light red color, fine-grained and somewhat friable.

The result of the analysis is as follows:

Silica,	73.34	per	cent.
Oxide of iron,	5.45	"	"
Alumina,	14.75	"	"
Lime,	.28	"	"
Magnesia,	.05	"	"
Potassa.	traces.		
Soda,	traces.		
Water,	4.71	"	"
	98.58		

The analysis was made by C. F. Sidener.

Chemical series, No. 140. A sample of a loose and friable, rather coarse-grained sandrock of a greenish brown color, furnished by Mr. ——— Norton from a point in the western suburbs of Minneapolis in proximity to certain springs highly charged with iron.

Only a partial analysis of the material was made. The material was first rubbed to a state of loose sand with water, and then submitted to a process of elutriation, in which several quantities of liquid containing finely suspended matter were obtained. These were permitted to subside, the sediment still retaining to some extent the greenish tinge of the original mass. A quantity of the finest part of this sediment, after being air-dried, was submitted to a partial analysis. It lost on ignition 18.39 per cent., water and organic matter. The remainder was found to contain 45.56 per cent. oxide of iron, the balance being finely divided sand and clay.

Microscopic examination of the same subsided matter showed a nearly homogeneous mass of very fine, rounded, light-brown particles, with here and there greenish, irregular, flat objects which were judged to be portions of some low vegetable growth.

It was concluded that the peculiar color of the mass as found was due to the vegetable matter distributed over and through it and to the brown oxide of iron, and not to any special mineral substance.

Examination of this substance by J. A. Dodge.

Chemical series, No. 141. Sample of the water of lake Minnetonka.

This sample of water was taken about half way between Excelsior and Morse's island, May 21st, 1883, by Mr. Wm. A. Noyes. The analysis was begun immediately and was completed about the first of June. The results of the chemical analysis are as follows:

	Parts per million.	Grains per gallon.
Silica,	4.8	2.8
Iron,	traces.	
Calcium carbonate,	70.0	4.088
Magnesium carbonate,	27.7	1.618
Lithium carbonate,	traces.	
Potassium nitrate,	traces.	
Potassium carbonate,	4.5	.263
Sodium carbonate,	1.4	.082
Sodium phosphate,	traces.	
Sodium chloride,	1.3	.076
Borax,	traces.	
Sodium sulphate,	traces.	
	109.7	6.407

The amount of dissolved salts is on the whole rather small. It is remarkable for the almost total absence of sulphates. The water was also found to be very pure organically, the permanganate test of Forschammer and Tidy indicating very little organic matter.

The analysis was made by W. A. Noyes.

Chemical series, No. 142. Sample of water from Hunter's Hot Springs, Montana. This analysis was made in the early part of June, 1883. The results are as follows:

	Parts per million.	Grains per gallon.
Silica,	77.4	4.517
Alumina,	1.2	.070
Oxide of iron,	traces.	
Carbonate of lime,	4.0	.233
Magnesium carbonate,	traces.	
Lithium carbonate,	traces.	
Potassium carbonate,	5.5	.321
Sodium carbonate,	150.5	8.785
Sodium chloride,	24.7	1.442
Sodium bromide,	traces.	
Sodium iodide,	traces.	
Sodium sulphide,	14.6	.852
Sodium sulphate,	10.4	.607
Sodium phosphate,	traces.	
Sodium biborate (borax),	traces.	
	288.30	16.827

The analysis was made by W. A. Noyes.

Chemical series, No. 143. Sample of a spring water from Inglewood (west of Minneapolis), furnished by Mr. Geo. P. Bradbury. This analysis was made in the early part of July. The results are as follows:

	Parts per million.	Grains per gallon.
Silica,	20.9	1.22
Oxide of iron and alumina (the latter in very small amount),	.2	.012
Calcium carbonate,	167.8	9.794
Calcium sulphate,	2.0	.117
Calcium nitrate,	minute traces.	
Calcium phosphate,	traces.	
Magnesium carbonate,	80.4	4.693
Lithium carbonate,	traces.	
Sodium sulphate,	8.3	.485
Sodium chloride,	1.3	.076
Potassium sulphate,	2.9	.169
Total determined,	283.8	16.566

This water has a considerable amount of salts in solution.

Analyzed by W. A. Noyes.

Chemical series, No. 144. Sample of the material used at Mankato for making hydraulic cement. This material is of fine granular texture, and of a very light grey color.

The powdered substance was digested in hydrochloric acid, whereby the greater part of it was dissolved with effervescence due to the escape of carbonic acid gas. The composition of the insoluble and the soluble portions is as follows:

Insoluble in HCl.			*Soluble in HCl.*		
Silica,	16	per cent.	Silica,	traces.	
Alumina,	5	per cent.	Alumina,	.85	per cent.
Potash,	traces.		Oxide of iron,	2.73	“ “
Soda,	traces.		Calcium carbonate,	40.00	“ “
			Magnesium carbonate,	31.50	“ “
	21.00		Potash,	.22	“ “
			Soda,	.54	“ “

Combined.

Insoluble,	21.00	per cent.
Soluble,	75.84	“ “
Water,	.43	“ “
	97.27	

The soluble portion is seen to be mainly carbonate of lime and carbonate of magnesia, with some oxide of iron, while the insoluble portion is silicate of alumina.

Analysis by C. F. Sidener.

Chemical series, No. 145. Sample of hydraulic cement made at Mankato.

This material was found to effervesce very little with hydrochloric acid. It was accordingly analyzed as a silicate, by fusion, in the usual manner. The result of the analysis is as follows:

Silica,	16.24	per cent.
Alumina,	5.35	“ “
Oxide of iron,	4.71	“ “
Lime,	38.53	“ “
Magnesia,	22.73	“ “
Potash,	1.81	“ “
Soda,	.57	“ “
Water.	.51	“ “
Carbonic acid,	9.26	“ “
	99.71	

Analysis by C. F. Sidener.

Chemical series, No. 146. A sample of clay of a light color, compact and dry.

This was analyzed by fusion in the usual manner for silicates. The result of the analysis is as follows:

Silica,	68.70	per cent.
Alumina,	18.04	" "
Oxide of iron,	1.53	" "
Lime,	1.24	" "
Magnesia,	.56	" "
Potash,	5.28	" "
Soda,	.24	" "
Phosphoric oxide,	.09	" "
Water,	1.40	" "
Organic matter,	traces.	
	97.08	

The material is rather remarkable for containing so much potash, which probably exists in it in the form of finely divided potash feldspar.

On ignition this clay changes only a little in color, becoming slightly brownish.

Analysis by C. F. Sidener, mainly.

Very respectfully yours,
JAMES A. DODGE.

NOTE. The foregoing substances were derived as follows:

No. 84. Was furnished by Mr. James M. Young. It was from the drift, and had the appearance of being similar to the phosphatic nodules derived from the Cretaceous in South Carolina. It was found at the main Two rivers, in Morrison county, a locality where the Cretaceous strata are known to exist. Mus. Reg. No. 4711.

No. 85. Zeolitic mineral from the trap rocks of the north shore of Lake Superior, Sec. 29, T. 57,6, a few miles west of Little Marais. It is number 634 A, of the geological survey series of crystalline rocks. Tenth annual report, p. 63.

No. 86. From Beaver Bay; found filling thin seams in the feldspar masses, from one-fourth to one-half an inch thick. It is a light flesh-colored, zeolitic mineral, with a radiated structure; corresponds to No. 637 A, of the series for the crystalline rocks. Tenth annual report, p. 64.

No. 126. Water from the Red river of the North, at Saint Vincent. Collected June 10, 1882, by Mr. C. F. Sidener.

No. 127. Water from the Red river of the North at Fergus Falls. Collected by Mr. Sidener, June, 1882.

No. 128. Water from Heron lake, Jackson county. Collected in June, 1882, by Mr. C. F. Sidener.

No. 129. Water from the falls of Pigeon river; obtained through Mr. Henry Mayhew, August, 1882.

No. 130. Water from lake Superior, near Grand Marais; obtained through Mr. Henry Mayhew, September, 1882.

No. 131. Water from an artesian well at Carman in Polk county; obtained through chief engineer C. C. Smith, Sept. 1882.

No. 132. Water from the mineral spring of C. F. Bryan, near Minnesota City. Collected in September, 1882. From Mr. C. F. Bryan.

No. 133. Water from the Rock river, sec. 19, T. 103, 44, near Luverne, Rock county; obtained through Hon. J. P. Kniss, November, 1882.

No. 137. Oölitic ferruginous rock from the Trenton, or Hudson River shales, fossiliferous, at the horizon of the *green shales*, at the railroad cut near Fountain, Fillmore county. Mus. Reg. No. 4978.

No. 138. Sample from the clay lying between the Shakopee limestone and the Jordan sandstone, immediately south of the Red Jacket railroad bridge, near Mankato, Blue Earth county. Furnished by Mr. J. G. Köller.

No. 139. Same as the last, but of a red color.

No. 140. Greenish, ferruginous, somewhat gritty substance, found about six feet below the natural surface, on land of W. W. Norton, near Minneapolis, or in a ditch by the roadside, about a mile north of Minnehaha creek, in the extension of Park avenue, in the valley of drainage from a marsh to Minnehaha creek, occurring somewhat as a bog ore.

No. 141. Water from lake Minnetonka, obtained by Wm. A. Noyes, May 21, 1883.

No. 142. Water from Hunter's Hot springs, Montana, furnished by Dr. Hunter, June, 1883.

No. 143. Water from a natural spring at Inglewood (west of Minneapolis), furnished by Mr. George P. Bradbury, June, 1883.

No. 144. Hydraulic limestone, used by the Standard Cement company, at Mankato, selected by the superintendent, Oct. 1883.

No. 145. Hydraulic lime, manufactured from the strata of the Shakopee formation, by the Standard Cement company at Mankato. Furnished by the superintendent.

No. 146. White clay, lying between the Shakopee limestone (dislodged) and the Jordan sandstone, on L' Huillier mound, at the mouth of the Blue Earth river.—N. H. WINCHELL.

VIII.

MUSEUM REPORT FOR 1882.

During the year 1882 the usual increase has been made in the collections of the museum. Four hundred and sixty-four entries have been made in the register. Some of these entries, as heretofore, are for the purpose of preserving records of specimens that are yet to undergo scientific examination, and are not enumerated in the following list of registrations. They have, however, been labeled and numbered to correspond with the records. These unnamed specimens are derived largely from the geological survey. The others are entered in the register under the names which they have when they come to us, unless known to be wrong, whether presented or obtained by exchange.

Exchanges have been made with Prof. C. U. Shepard, John H. Goodale, Prof. S. Calvin, and Dr. J. W. Hood.

The principal donors to the museum registered in 1882 were Dr. E. S. Dana, Gen. H. H. Sibley, Lieut. A. W. Vogdes, A. J. Noyes, F. D. Anthony, N. H. Winchell, Cora E. Goode, W. J. McGee, W. H. Shelton, C. L. Herrick, J. C. Kassube and Horace V. Winchell. All these donations, and others, are enumerated in the following list.

SPECIMENS REGISTERED IN THE MUSEUM IN 1882.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
4691	1882	C. U. Shepard	Meteoric Iron wt., 41.5 grs	1	Aeriotopos, Col		By exchange with Prof. C. U. Shepard.
4692	"	"	" " " 7.05 "	1	Morro do Rizio (Santa Catarina), Brazil		By exchange with Prof. C. U. Shepard.
4693	"	"	" " " 6.2 "	2	Putnam Co., Georgia		By exchange with Prof. C. U. Shepard.
4694	"	"	" " " 105.6 "	2	Toluca, Mexico		By exchange with Prof. C. U. Shepard.
4695	"	"	" " " 5.4 "	1	Mejillones, Chili		By exchange with Prof. C. U. Shepard.
4696	"	"	" " " 3.8 "	S'v'rl	Zacatecas, Mexico		By exchange with Prof. C. U. Shepard.
4697	"	"	" Stone " 0.4 "	1	Vouille, France		By exchange with Prof. C. U. Shepard.
4698	"	"	" " " 3.1 "	1	Cabarras, N. C.		By exchange with Prof. C, U. Shepard.
4699	"	"	" " " 2.4 "	P'w'd	Bishopville, S. C		By exchange with Prof. C. U. Shepard.
4700	"	Presented	Incrustation from Giant Geyser	1	National Park	Recent	From Frank Bush ; presented by Prof. H. S. Baker.
4701	"	"	"Satin spar," rose-colored	1	Monument Park, Col		Presented by Dr. A. F. Elliott.
4702	"	"	Pyrargyrite ("ruby silver")	1	Georgetown, Col		" " " " "
4703	"	By purchase	"Rock soap"	1	Near San Buenaventura, Cal		From I. F. Saxly, obtained through Rev. C. B. Sheldon.
4704	1881	By exchange	Staurolite crystals	Indf.			From Prof. C. U. Shepard.
4705	"	"	Staurolite, twinned & intergrown crystals	"			" " " "
4706	1882	Presented	Sandstone	3	Dresbach	St. Croix	Presented by J. S. Tostevin, of St. Paul.
4707	"	"	Columbite, fine crystals	1	Branchville, Conn		Presented by Dr. Edw. S. Dana of Yale College.

4708	1882	Presented	Columbite crystals with calcite	2	Branchville, Conn		Presented by Dr. Edw. S. Dana, of Yale College.
4709	“	“	“ .massive	1	“ “		Presented by Dr. Edw. S. Dana, of Yale College.
4710	“	“	Chalcopyrite crystals, on quartz	1	“ “		Presented by Dr. Edw. S. Dana, of Yale College.
4711	“	Geol.&Nat. Hist. Survey	Phosphatic, (?) ferruginous nodule	1	Main Two Rivers, Mor. Co	Drift from the Cret.	Presented by James M. Young.
4712	“	Presented	Silicified wood	10	Valley of the Yellowstone, Montana		Presented by Gen. Sibley.
4713	“	“	Opal and chalcedony fragments	16	Ofallon creek, Montana		“ “ “ “
4714	“	“	Quartz (chalcedony) fragments	10	Mouth of Green river, Dak		“ “ “ “
4715	“	“	Pyrite concretions	2	Near Sentinel Butte		“ “ “ “
4716	“	“	Gypsum	1	Heart river, Dakota		“ “ “ “
4718	“	“	“Horn Silver”	1	Tin Cup Mining Dist'ct, Gunnison Co., Col		“ “ J. W. Bird.
4719	“	“	Oolyte	2	Stillwater		“ “ A. D. Roe.
4720	“	By exchange	Andalusite (chiastolite)	5	Lancaster, Mass		From John H. Goodale.
4721	“	“	Claystones (concretions in clay, modified drift)	8	Headwaters of the Connecticut river in N. H.	Recent	“ “ “
4736	“	Presented	Deposit from Castle Geyser	1	Yellowstone Nat. Park	“	Presented by D. P. Jones.
4737	“	“	Deposit from hot springs	6	Mt. Johnson, near Gibbon Geyser Basin, Yellowstone Nat. Park		“ “ A. J. Noyes.
4738	“	“	“ “ “ “	1	Yellowstone Nat. Park		“ “ “
4739	“	“	“ “ “ “	1	“ “ “		“ “ “
4740	“	“	“ “ “ “	5	“ “ “		“ “ “
4741	“	“	“ “ “ “ (“Paint-pots”)	8	“ “ “		“ “ “
4742	“	“	Horse-shoe, coated by the Mammoth Sp'g	1	“ “ “		“ “ “
4743	“	“	“Geyser-egg” (pencil-writing indelible)	1	“ “ “		“ “ “
4744	“	“	Sulphur, crystalline	4	Sulphur Mt., 12 miles above the Great F'lls of the Yellowstone, in the National Paak		“ “ “
4745	“	“	Obsidian	1	Obsidian Mtn., Yellowstone Nat. Park		“ “ “
4746	“	“	Silicified wood	2	Yellowstone Nat. Park		“ “ “
4747	“	“	Gold-bearing quartz	2	Bear Gulch, 6 ms. S. of the Yel. Nat. Park, Wyoming		“ “ “
4748	“	“	Silver and Gold,—(the latter “retort”)	Indef	Summit Valley dis'ct, S'lv'r Bow Co., Mont'a		“ “ “
4749	“	“	Silver ore, Original mine	3	“ “ “		“ “ “
4750	“	“	“ “ Gagnon lode	2	“ “ “		“ “ “
4751	“	“	“ “ Bell mine	1	“ “ “		“ “ “
4752	“	“	“ “ Star West mine	3	“ “ “		“ “ “

Specimens registered in the museum in 1882.—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
4753	1882	Presented	Silver ore, Star West mine.....	2	Summit Valley disc't, S'lv'r Bow Co., Mont'a	....	Presented by A. J. Noyes.
4754	"	"	" " Anselmo mine............	3	" " "	....	" " "
4755	"	"	" " Mountain Boy mine...........	2	" " "	....	" " "
4756	"	"	" " Trarona mine.................	1	" " "	....	" " "
4757	"	"	" " Black Chief mine.......... ...	1	" " "	....	" " "
4758	"	"	" " Vulcan mine....................	1	" " "	....	" " "
4759	"	"	" " Alice mine.......................	1	" " "	....	" " "
4760	"	"	*Graptolithus pristis*, Hall..................	3	Near Sandy Hill, N. Y..	Utica Sl'te	" " Prof. C. W. Hall.
4761	"	"	Iron ore, hematite; Mastodon mine.......	1	Mastodon, Mich., Lake Superior region.......	....	" " F. D. Anthony.
4762	"	"	" " " Porteos Explorat'ns..	1	Near Mastodon, Mich., L. Superior region ...	....	" " "
4763	"	"	" " " Carry mine..........	1	Near Vulcan, Mich., L. Superior region.......	....	" " "
4764	"	"	" " " Cascade mine........	1	Cascade, Mich., Lake Superior region.......	....	" " "
4765	"	"	Iron ore, hematite; Quinnesec mine......	1	Quinnesec, Mich., L'ke Superior region.......	....	" " "
4766	"	"	" " " ("steel ore") Cleveland mine..........................	1	Ishpeming, Mich., L. Superior region.......	....	" " "
4767	"	"	Iron ore, hematite; Cleveland mine.... ..	3	" "	....	" " "
4768	"	"	" " " ("slate ore"), N. Y. mine	1	" "	....	" " "
4769	"	"	From Ropes Gold and Silver mine........	3	" "	....	" " "
4770	"	"	Core from diam'd drill, 400 ft. b'l'w surface	4	" "	....	" " "
4771	"	"	Iron ore, hematite, South Republic mine.	1	Near Republic, Mich., L. Superior region....	....	" " "
4772	"	"	" " " Breen mine	2	Wancedale, Mich., L'ke Superior region.......	....	" " "
4773	"	"	" " " Metropolitan mine....	1	Metropolitan, Mich. Felch Mt, range, L Superior region.......	....	" " "

4774	1882	Presented	" " "		3	Felch Mt., Mich., L. Superior region		Presented by F. D. Anthony.
4775	"	"	Quartz (jasper)		1	" "		" " "
4776	"	"	Marble		1	" "		" " "
4777	"	"	Iron ore, hematite, covered by botryoidal limonite		1	Superior mine, Ishpeming, Mich., L. Superior region		" " "
				[Prof. S.'s No.				
4778	Oct. 3, '82	By exchange	Pihlite (cymatolite)	2322	1	Chestfield, Mass		From Prof. C. U. Shepard.
4779	"	"	Serpentine (chrysotile) in deweylite	2323	1	Templeton, Canada		" " "
4780	"	"	Apatite, red-brown	2324	1	Grattan, Ontario, Can		" " "
4781	"	"	Chalcophanite on hetærolite	2325	1	Sparta, New Jersey		" " "
4782	"	"	Hematite and Quartz	2326	1	Fowler, N. Y		" " "
4783	"	"	Garnet (uwarowite) on nickeliferous augite	2327	1	Wakefield, Canada		" " "
4784	"	"	Psilomelane	2328	1	Woodstock, Alabama		" " "
4785	"	"	Hausmannite	2329	1	Ilmenau, Thuringia		" " "
4786	"	"	Uraninite and gummite	2330	1	Mitchell Co., N. C		" " "
4787	"	"	Apatite (yellow)	2331	1	Odegarden, Norway		" " "
4788	"	"	Cancrinite and bluish green nephelite (elæolite)	2332	1	Litchfield, Maine		" " "
4789	"	"	Libethenite	2333	1	Cornwall, England		" " "
4790	"	"	Celestite	2334	1	Bristol, England		" " "
4791	"	"	Vesuvianite (cyprine) and zoisite (thulite)	2335	1	Tellemark, Norway		" " "
4792	"	"	Crocidolite	2336	1	Templeton, Canada		" " "
4793	"	"	Anthophyllite, with chalcopyrite and pyrrhotite	2337	1	Villa Rica, Georgia		" " "
4794	"	"	Cuprite	2338	1	Ural Mts		" " "
4795	"	"	Celestite	2339	1	Herrengrund, Hungary		" " "
4796	"	"	Martite, in syenite	2340	1	Dresden, Saxony		" " "
4797	"	"	Hydrotalcite	2311	1	Vernon, New Jersey		" " "
4798	"	"	Mimetite (hedyphane)	2342	1	Langban, Sweden		" " "
4799	"	"	Cassiterite	2343	1	Cornwall, England		" " "
4800	"	"	Cuprite	2344	1	" "		" " "
4801	"	"	Œrstedite	2345	1	Chesterfield, Mass		" " "
4802	"	"	Pinite (killinite)	2346	1	" "		" " "
4803	"	"	Orthoclase (perthite)	2347	1	Perth, n'r Burgess, Can		" " "
4804	"	"	Bornite and cuprite	2348	1	Plumas Co., California		" " "
4805	"	"	Scapolite, massive, blue	2349	1	Templeton, Canada		" " "
4806	"	"	Titanite (lederite)	2350	1	Grattan, Renfrew Co., Canada		" " "
4807	"	"	Amphibole and albite	2351	1	Snarum, Norway		" " "
4808	"	"	Pyroxene (augite)	2352	1	Templeton, Canada		" " "
4809	"	"	Orthoclase, twin crystals	2353	1	Furhsberg, Silesia		" " "
4810	"	"	*Eozoon Canadense*, Dawson	2354	1	Templeton, Canada		" " "
4811	"	"	Scapolite and pyroxene (augite)	2355	1	" "		" " "
4812	"	"	Glauconite with apophyllite	2356	1	Ghauts Mts., India		" " "
4813	"	"	Octahedrite (anatase)	2357	1	Tavesch, Grisons		" " "

Specimens Registered in the museum in 1882.—Continued.

Serial Number.	OBTAINED.		NAME	[Prof. S.'s No.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.						
4814	Oct. 3, '82	By exchange	Greenockite (yellow powder), in a compact rhodonite (fowlerite), tephroite, garnet, and willemite (troostite)?......	2358	1	Franklin, N. J..........	....	From Prof. C. U. Shepard.
4815	"	"	Willcoxite and centhophyllite	2359	1	Franklin. N. C.... .. .	....	" " "
4816	"	"	Perofskite	2360	1	Ackmatowsk mine, Russinsk, Urals.......	....	" " "
4817	"	"	Tridymite, in trachyte................	2361	1	Siebengeberge, Prussia	....	" " "
4818	"	"	Spinel (rubies),—(in test-tube)	2362	Many	Ceylon	....	" " "
4819	"	"	Cancrinite...............	2363	1	Litchfield, Maine.. ...	....	" " "
4820	"	"	Garnet................................	2364	1	Templeton, Cannda....	....	" " "
4821	"	"	Talc (rensselaerite).	2365	1	" "	....	" " "
4822	"	"	Malachite on chalcocite, which contains silver........	2366	1	Turrilnsk, Urals........	....	" " "
4823	"	"	Guano (pyroclasite)...................	2367	1	Moneta island, West Indies..	....	" " "
4824	"	"	Pelhamine............................	2368	1	Pelham, Mass..........	....	" " "
4825	"	"	Apatite, in red calcite................	2369	1	Grattan, Canada.......	....	" " "
4826	"	"	Titanite, amphibole, and augite.......	2371	1	Templeton, Canada...	....	" " "
4827	1882	Presented.	Cement stone, from Buck's quarry........		1	Mankato, Minn.........	Shakopee limestone	Presented by Hon. D. Buck.
4828	"	"	Travertine ("petrified moss")..		1	Two miles S. of Osceola Mills, Wis............	Recent springs.	" Prof. C. W. Hall.
4829	"	"	Rock salt.............		1	England....	....	" " "
4830	"	"	Granite, with Amazon stone as feldspar.		1	Mt. Desert, Maine......	... .	" Prof. J. A. Dodge
4831	"	exchange.....	*Acervularia davidsoni*, Ed. & H..........		1	Iowa City, Iowa........	Hamilton, Dev......	From Prof. S. Calvin.
4832	"	"	*Favosites billingsii*, Rom..................		1	Bartlett's Mills,Ontario Canada................	Hamilton, Dev......	" " "
4833	"	"	*Favosites placenta*. Rom. (two varieties)..		2	Bartlett's Mills,Ontario Canada...............	Hamilton, Dev......	" " "

4834	1882	By exchange	*Heliophyllum halli*, Ed. & H	2	Bartlett's Mills, Ontario, Canada	Devonian	From Prof. S. Calvin.
4835	"	"	*Cystiphyllum americanum*, Ed. & H.	2	" "	Hamilton, Dev.	" " "
4836	"	"	*Pachyphyllum woodmani*, White, (rare)	1	Lime Cr'k, Rockford, Ia	Dev. shales	" " "
4837	"	"	*Cyathophyllum multiplicatum*, Owen	2	Manchester. Iowa	Niagara, U. Sil.	" " "
4838	"	"	*Terebratula linklaeni*	3	Fayette, Iowa	Devonian	" " "
4839	"	"	*Spirfera pennata*, Owen	2	Independence, Iowa	Hamilton Dev	" " "
4840	"	"	" *mucronata*, Con.	7	Widder, Ontario, Can.	" "	" " "
4841	"	"	" *hungerfordi*, Hall	5	Lime creek, Iowa	Devonian	" " "
4842	"	"	" *whitneyi*, Hall	2	" " "	"	" " "
4843	"	"	" *orestes*, H. & Whitf.	3	" " "	"	" " "
4844	"	"	" *aspera*, Hall	1	Pine creek, Muscatine Co., Iowa	"	" " "
4845	"	"	" *parryana*, Hall	2	" " "	"	" " "
4846	"	"	*Athyris vittata*, Hall	13	" " "	"	" " "
4847	"	"	" " "	3	Iowa City, Iowa	Hamilton, Dev.	" " "
4848	"	"	*Leiorhynchus altus*, Calvin	3	Solon, Iowa	Devonian	" " "
4849	"	"	*Pentamerus oblongus*, Sowerby	3	Iowa	Niagara, U. Sil.	" " "
4850	"	"	*Atrypa aspera*, var. *occidentalis*	2	Independence, Iowa	Devonian	" " "
4851	"	"	" *reticularis*, Lin.	6	" "	Hamilton, Dev.	" " "
4852	"	"	" " "	9	Pine creek, Muscatine Co., Iowa	Devonian	" " "
4853	"	"	" " "	9	Lime creek, Iowa	"	" " "
4854	"	"	" *hystrix*, Hall	5	" " "	"	" " "
4855	"	"	*Orthis impressa*, "	4	Hackberry Grove, Iowa	Hamilton, Dev.	" " "
4856	"	By exchange	*Strophodonta reversa*, Hall	3	Lime creek, Iowa	Devonian.	" " "
4857	"	"	" *hybrida*, H. & W	3	" "	"	" " "
4858	"	"	" *canace*, H & W	2	" "	"	" " "
4859	"	"	" *exilis*, Calvin	3	" "	"	" " "
4860	"	"	" *arcuata*, Hall	2	" "	"	" " "
4861	"	"	*Productella dissimilis*, Hall	2	" "	"	" " "
4862	"	"	*Naticopsis gigantea*, H. & W. (casts)	3	" "	"	" " "
4863	"	"	*Batocrinus rotundus*, Shum	2	Burlington, Iowa	Burlingt'n beds, Sub-Carboniferous	" " "
4864	"	"	*Trigonocarpus*	2	Youngstown, Ohio	Coal Measures	" " "
4865	"	By purchase	*Goniasteroidocrinus tuberosus*	1	Crawfordsville, Indiana	....	From Prof. D. A. Bassett.
4866	"	"	*Onychocrinus exculptus*	1	" "	....	" " "
4867	"	"	*Platycrinus hemisphericus*	1	" "	....	" " "

Specimens registered in the museum in 1882.—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
4868	1882	By purchase	*Scaphiocrinus æqualis*	1	Crawfordsville, Indiana	....	From Prof. D. A. Bassett.
4869	"	"	*Poteriocrinus decadactylus*....	1	" "	....	" " "
4870	"	"	*Platyceras equilaterdlis*	3	" "	....	" " "
4871	"	Presented	Sandstone, dressed blocks..................	2	Dresbach, Minn........	St. Croix...	Presented by J. F. Testevin, of St. Paul.
4872	"	"	" " " (from weathered beds)	1	" "	" ...	Presented by J. F. Tostevin, of St. Paul.
4901	Aug. 1881	Presented.........	Magnetite...................	1	Eastern Tennessee.....	....	Presented by Gen. Wilder.
4902	"	"	Sandstone.......	2	Top of Lookout Mt., Tenn.	Sub-Carboniferous	Presented by N. H. Winchell.
4903	"	"	Oolyte..................................	1	Near Sherwood, Tenn..	"	" " " "
4904	"	"	Limestone...............................	1	Central Kentucky......	St. Louis limestone, Sub-Carboniferous	" " " "
4905	"	"	" (variegated)	1	High Bridge, Ky.........	Trenton...	" " " "
4906	"	"	" (fine-grained)	1	" "	"	" " " "
4907	"	"	Limestone.......	6	Montreal, Canada......	"	" " " "
4908	"	"	Limestone cut by dyke of igneous rock..	1	Mt. Royal, Montreal, Can	"	" " " "
4909	"	"	Eruptive rock, coarse-grained	8	" " "	... .	" " " "
4910	"	"	" " fine-grained; dyke cutting the limestone.	1	" " "	....	" " " "
4911	"	"	Metamorphic rock	1	" " "	....	" " " "
4912	Aug. 1882	"	Apatite	2	Ottawa, Canada........	....	" " " "
4913	"	"	Hematite	1	Haycock Iron Location, 7 miles from Ottawa, Canada....	....	" " " "
4915	1877	Geol. & Nat. Hist. Survey	Lignite (fragments in a bottle	Many.	Newberg, Mitchell Co., Iowa.........	Devonian.	N. H. Winchell.
4916	"	Geol. & Nat. Hist. Survey	Peat, interglacial,—18 inches thick........	Much..	Sec. 12, Windom, Mower Co.....................	Interglaial	" "

4917	1877	Geol. & Nat. Hist. Survey	Iron ore, concretionary	1	Austin		" "
4918	1882	Presented	Lignite	M'ny	Valley of the Redwood river	Cretace'us	Presented.
4919	"	"	Black clay, 85 feet below the surface	Svr'l.	Melotte, Dakota	"	Presented by C. H. Prior.
4920	"	"	Drillings from a well, 149 feet deep	"	New Richland, Waseca Co	"	" " C. E. Whelpley.
4921	"	"	Brass, melted and crystallized, from the heated journal of a car-wheel	1	Minnesota.		" " N. H. Winchell.
4922	"	"	Limestone fragments from the drift	12	Vicinity of Rockford, Wright Co	Drift	" " H. Ellington.
4924	"	"	Concretion of sandstone, spike-like	1	Sec. 21, T. 98, R. 4, Iowa		" " " "
4951	"	"	Stalactites and stalactitic crust	3	Olmsted Co	{ Recent springs	Presented by Miss Cora E. Goode.
4955	"	"	Native gold and silver, with argentite	1	Vein of the Bodie mine, Bodie, Cal		Presented by H. Augustus Whiting.
4956	"	"	Couuntry rock, with fronds of native silver	1	Bodie mine, Bodie, Cal.		" " "
4957	"	"	Arenaceous shale, cont'in'g scales of fishes	40	Railroad well, Aberdeen, Dakota	Cret.(?)	Presented by C. H. Prior.
4958	"	"	Concretion, calcareous	1	Dakota	"	" " M. A. Morey.
4959	"	"	Limestone	2	Decorah, Iowa	Trenton	" " W. J. McGee.
4960	"	"	Dolomite	3	State Quarry, Anamesa, Stone City, Iowa	Niagara	" " "
4961	"	"	"	4	Farley, Iowa	"	" " "
4962	"	"	"	2	Lemont, Illinois	"	" " "
4963	"	"	Limestone	2	Buffalo, Scott Co., Iowa	Hamilton	" " "
4964	"	"	Oolyte	2	Le Grand, Iowa	Kindern'k	" " "
4965	"	"	Hydraulic dolomite	4	Iowa Falls, Iowa	"	" " "
4966	"	"	Sandstone	1	Fairfield, Iowa	St. Louis	" " "
4967	"	"	Dolomite	2	Pella, Iowa	"	" " "
4968	"	"	Limestone	1	Sigourney, Iowa	Carbonif's.	" " "
4969	"	"	Sandstone	2	Buffalo, Scott Co., Iowa	Coal Measures	" " "
4970	"	"	Gypsum	1	Fort Dodge, Iowa	Jur. or Triassic	" " "
4979	"	{ Geol. & Nat. Hist. Survey }	Sandstone	7	Lewiston, Winona Co.	Jordan	N. H. Winchell.
4980	"	" "	"	22	Dresbach, "	St. Croix	"
4985	"	" "	Conglomerate	5	" "	"	"
4986	"	" "	Sandrock, with fucoidal markings	12	" "	"	"
4987	"	" "	Soil (loess-loam)	Much	St. Charles, "	Recent	"
4988	"	" "	Sub-soil	"	" "	"	"
4989	"	" "	"	"	Pickwick, "	"	"
4990	"	" "	Brick-clay	"	Dresbach, Winona Co.	Alluvial	"
4991	"	" "	Brick, red; (Sherwood & Johnson)	1	" " "		"
4992	"	" "	" pressed, sunburned; (Sher. & John.)	1	" " "		"
4993	"	" "	" red; (Biesanz)	1	Winona, " "		"
4994	"	" "	Limestone	1	LaCrosse, Wisconsin	St. L'wr'nc	"

Specimens registered in the museum in 1882.—Concluded.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
4995	1882	Geol. and Nat. Hist. Survey.	Calcarous concretions	20	Bryan's, near Minnesota City	Lœss-loam	N. H. Winchell.
5003	"	" "	Concretions from the green shales	50	Sec. 16, Minneola, Goodhue county	Hudson River	"
5007	"	Presented	Slabs showing glacial striation and polishing.	4	Quarry opp. the University, Minneapolis.	Trenton	Presented by C. L. Herrick.
5018	"	"	Pebble, black, ½ inch long; in Trenton limestone	1	Minneapolis	"	" "
5068	"	Geol. and Nat. Hist. Survey.	Calcite, in drusy cavity	1	"	"	N. H. Winchell.
5120	"	" "	Calcite crystals	4	"	"	C. L. Herrick.
5145	1881	Presented	Brick-clay,	3	Collingwood, Meeker county	Modified Drift	Presented by Mr. Pendergast.
5146	"	"	Peat	2	Near Coon creek, Anoka Co.	Recent	" Dwight Mitchell.
5147	"	"	*Orthis Kassubæ*, Winchell	1	Minneapolis	Trenton	" J. C. Kassube.
5148	"	"	" *perveta*, Con.	1	"	"	" "
5149	"	"	" *subæquata*, Con.	2	"	"	" "
5150	"	"	" *tricenaria*, Con.	1	"	"	" "

ARCHÆOLOGICAL ADDITIONS TO THE MUSEUM IN 1882.

74. Fragments of Indian pottery. From the northwest shore of Mille Lacs. Collected by Warren Upham.

75. Lock of Dirt-in-the-Face's hair, braided. Miles City, Montana; Nov. 1, 1881. Presented by Col. J. B. Clough.

76. Arrow-point of chert; narrow. From a mound at Dresbach, Winona county. Presented by George B. Dresbach, Jr.

77. Copper chisel, 1¼ to 2 inches broad, 6 inches long. From the same mound at Dresbach. Presented by George B. Dresbach, Jr.

78. Copper chisel, 1 to 1⅛ inches wide, 7 inches long. From the same mound with the preceding. Presented by John H. Mosse.

79. Piece of pottery, also from the same mound at Dresbach. Presented by John H. Mosse.

80. Fragment of a human skull. From the same mound. Presented by John H. Mosse.

81. Piece of pottery, from the largest (nine feet in hight) in a group of sixteen mounds, N. E. ¼ of sec. 31, Greenwood, Hennepin Co. (at junction of creek, outlet from Lake Sarah, with the Crow river.) Presented by H. Ellington.

82. Fragment of a bone, from the same mound with the last. Presented by H. Ellington.

83. Angular fragments of chert (chipped?). Found between Mankato and South Bend, and presented by Rev. Louis J. Hauge.

84. Lance-head of gray chert, notched at base, unsymmetrical. Record lost.

85. Imperfect arrow-point of gray quartzyte. Record lost.

86. Arrow-points of flint and chert; three, all notched at base. Records lost.

87. Spear-point of quartzyte. From Martha's Vineyard. Presented by Mrs. Maj. C. J. Allen.

88. Arrow-point of flint, small, triangular. From Martha's Vineyard. Presented by Mrs. Allen.

89. Low, conical disk of limonite, polished, with a thin edge. From Sherwood, Tennessee. Presented by N. H. Winchell.

90. Rose-quartz arrow-point, with unnotched base. From Sherwood, Tennessee. Presented by N. H. Winchell.

91. Small, quartz arrow-point. From Sherwood, Tennessee. Presented by N. H. Winchell.

92. Arrow-points (six) of chert, with notched base. From Sherwood, Tennessee. Presented by N. H. Winchell.

93. Stone implements (five), with broad, notched base. From Sherwood, Tennessee. Presented by N. H. Winchell.

94. Implements (five) of chert, rudely chipped. From Sherwood, Tennessee. Presented by N. H. Winchell.

95. Chert clippings (twenty-three.) From Sherwood, Tennessee. Presented by N. H. Winchell.

96. Stone arrow-points (forty), notched at the base. From Waterloo, Alabama. Presented, Oct., 1882, by C. L. Herrick.

97. Stone arrow points (five), triangular, notched at base. From Waterloo, Ala. Presented, Oct., 1882, by C. L. Herrick.

98. Stone arrow-points (nineteen), unnotched. From Waterloo, Ala. Presented by C. L. Herrick.

99. Large arrow-point, of concretionary chert. From Waterloo, Ala. Presented by C. L. Herrick.

100. Unsymmetrical stone arrow-points (six). From Waterloo, Ala. Presented by C. L. Herrick.

101. Stone lance-heads (nineteen). From Waterloo, Ala. Presented by C. L. Herrick.

102. Fragmentary stone arrows and lance-points (seventy-seven). From Waterloo, Ala. Presented Oct., 1882, by C. L. Herrick.

103. Stone hatchets and fragments (fifteen). From Waterloo, Ala. Presented by C. L. Herrick.

104. Elongated implements of stone (twenty). From Waterloo, Ala. Presented by C. L. Herrick.

105. Implement of red chert. From Waterloo, Ala. Presented by C. L. Herrick.

106. Stock from which stone implements were made (twenty-eight pieces). From Waterloo, Ala. Presented, Oct., 1882, by C. L. Herrick.

107. Stone chippings (eighty-five). From Waterloo, Ala. Presented by C. L. Herrick.

108. Implement of dark, reddish-brown quartzyte. From Decatur, Alabama. Presented, Oct., 1882, by C. L. Herrick.

109. Implement (hide-dresser) of trappean rock. From Decatur, Ala. Presented by C. L. Herrick.

110. Fragments (eighty-one) of Indian pottery. From Eastport, Mississippi. Presented by C. L. Herrick.

111. Shells (thirty-two gasteropods and three lamellibranchs) from shell-bed (pre-historic kitchen-midden ?) in bank of the Tennessee river, Waterloo, Alabama. Presented, Oct., 1882, by C. L. Herrick.

APPENDIX.

MINNESOTA LAWS RELATING TO MINES AND MINING.

ABSTRACTED BY C. L. HERRICK.

GENERAL LAWS.

General Laws, 1858, p. 250. This is a general act to regulate corporations for manufacturing, mining, agricultural, mechanical and chemical purposes, defining the methods of association, the capital stock, the rights of stock-holders and their joint and individual liabilities for the debts and obligations of the corporation.

General Laws, 1860, p. 173. *An act to authorize the formation of corporations for mining, smelting, or manufacturing iron, copper, silver or other ores or minerals.*

Be it enacted by the Legislature of the State of Minnesota.

Section 1. All corporations organized under the provisions of this act, shall be capable of suing and being sued in any court of this state, and may have a common seal, and alter the same at pleasure, may elect or appoint in such manner as they shall determine, all necessary officers and agents, and may fix their compensation and determine their duties and make from time to time, such by-laws not inconsistent with the constitution and laws of this state, as a majority of the stock-holders shall direct.

Sec 2. Any number of persons not less than three, who shall, by articles of agreement in writing, associate according to the provisions of this act, under any name assumed by them, for the purpose of engaging in and carrying on mining, smelting or manufacturing iron, copper, silver or other minerals, and who shall comply with the provisions of this act, shall with their successors and assigns constitute a body politic and corporate in fact and name, under the name assumed by them in their articles of association.

Provided. No company shall take a name previously assumed by any other company.

Sec. 3. Before any company formed under this act shall commence business, the president and directors shall cause their articles of association to be filed with the secretary of state of this state, and also a copy thereof with the register of deeds of the county in which its principal business is to be conducted; where said articles shall be recorded at length in books prepared for that purpose.

Sec. 4. The articles of every such association shall be signed by the persons associating in the first instance, and acknowledged before some persons authorized by law to take the acknowledgement of deeds, and shall state

First. The distinct purpose for which the association is formed.

Second. The amount of their capital stock and the number of shares.

Third. The amount of capital stock actually paid in.

Fourth. The place in the state where their office for the transaction of business is to be held, and the county or counties in which their business is to be carried on.

Sixth. The term of its existence, not to exceed thirtv years.

Sec. 5. The amount of capital stock in every such corporation shall, in no case be less than ten thousand (10,000) dollars nor more than five hundred (500,000) dollars, and shall be divided into shares of fifty dollars each; but the capital stock and number of shares may be increased at any regular meeting of the stockholders.

Provided. The amount of capital when so increased shall not exceed the sum of five hundred thousand (500,000) dollars.

Sec. 6. The purposes for which such corporations shall be established, shall be distinctly and definitely specified in the articles of association; and it shall not be lawful for said company to appropriate its funds for any other purpose.

Sec. 7. Any two of the signers of such articles of association may call the first meeting of the corporators for the purpose of organizing the company, at such time and place as they may appoint, by giving personal notice to each corporator, or by publishing the same in some newspaper at least fifteen days before the time appointed for such meeting.

Sec. 8. The stock, property and business of such corporation shall be managed by not less than three nor more than seven directors, as the articles may determine, one of whom shall be a resident of the state; they shall hold their offices for one year, and until their successors shall be duly chosen. The time and place of the meeting of stockholders for the election of directors and other purposes, shall be fixed by the by-laws, and at all such meetings each share of stock shall be entitled to one vote.

Sec. 9. The directors of every such corporation shall choose one of their number president, and shall appoint such other officers and agents as the articles of association or by-laws may require, who shall hold their offices for one year, or until a majority of the stockholders choose others in their stead. The majority of directors for the time being, shall have power to fill any vacancy which may happen in their board by death, resignation, or otherwise, until the next regular meeting of the stockholders.

Sec. 10. The directors may call in the subscription to the capital stock of such corporation by installments in such portion and at such times and places as they shall think proper, by giving notice thereof as the by-laws shall prescribe, and in case any stockholder shall neglect or refuse payment of any such installment for the space of sixty days after the same shall have become due and payable, and after he shall have been notified thereof, the stock of said delinquent stockholder may be sold by the directors at public auction, at the office of the secretary of such corporation, giving at least thirty days notice in some newspaper in the county in which said office is located.

Provided. That if said stockholder is a resident of this state, the stock shall be sold at the business office of said corporation in the county in which its business is conducted, giving at least thirty-days notice thereof in some newspaper printed in the county and if no newspaper is published in said county, then it shall be published in some newspaper at the capital of the state, and the proceeds of such sale shall be first applied in payment of the installment called for, and the expense of the sale, and the residue shall be refunded to the person entitled to the same, and such sale shall entitle the purchaser to all the rights of a stockholder to the extent of the shares so bought.

SEC. 11. A majority of the directors of any such corporation for the time being, convened according to the by-laws, shall constitute a quorum for the transaction of business; and those holding a majority of the stock at any meeting of the stockholders shall be capable of transacting the business of the meeting, and at all such meetings stockholders may vote in person or by proxy duly filed.

SEC. 12. If it shall so happen than an election of directors shall not take place at the annual meeting, such corporation shall not in consequence thereof be dissolved; but an election may be held at any time thereafter by giving thirty days notice thereof in the manner provided in the by-laws of the company.

SEC. 13. Every such incorporation shall have power to acquire, hold, and transfer all such real and personal estate as the directors shall adjudge necessary or convenient for the purpose of conducting, carrying on, or disposing of the business of such corporation.

Provided. That its real estate held at any one time shall not exceed three thousand acres.

SEC. 14. The stock of any such corporation shall be deemed personal property, and shall be transferable only on the books of such company in such form as the directors shall prescribe, and such corporation shall at all times have a lien upon the stock or property of its members invested therein for all debts due from them to such corporation, which may be enforced by advertisement and sale in the manner provided for selling delinquent stock.

Provided. That assessors and all other officers, whose duty it may be to assess property for purposes of taxation, may take into consideration the productiveness or unproductiveness of the mine, stock and improvements thereto belonging, and value the same accordingly.

SEC. 15. The directors shall cause a record to be kept of all stock subscribed and transferred, and of all business transactions, and their books and records shall at all times be open to the inspection of any and every stockholder; they shall also when required present to the stockholders reports in writing of the situation and amount of business of the company, and declare and make such dividends of the profits from the business of the company, not reducing the capital stock, while they have outstanding liabilities.

SEC. 16. The directors of any company organized under this act, shall have power to establish one or more offices without this state, and transact business thereat.

Provided, however. That an office shall always be maintained in this state where legal processes may be served on the person in charge thereof.

SEC. 17. Each stockholder in any company organized under this act, shall be liable for the debts of the company to the amount of stock held or owned by him therein.

SEC. 18. This act shall take effect from and after its passage.

Approved Feb. 24, 1860.

GENERAL LAWS, 1860. p. 258. *An act to amend an act entitled "An Act to regulate corporations for manufacturing, mining, agricultural, mechanical and chemical purposes," passed Aug. 12, 1858.* This amendment provides that any corporation created before the passage of the original act may by vote of its stockholders avail itself of its privileges.

GENERAL LAWS OF MINNESOTA, 1864, p. 111. *An Act to provide for a geological survey of the north shore of lake Superior, within the limits of this state, and other mineral and coal districts, and to appropriate money therefor.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That there be and is hereby appropriated, out of any moneys in the treasury not otherwise appropriated, the sum of two thousand dollars, to be expended, or so much thereof as may be necessary, under the direction of the governor, in causing to be made a geological survey of the mineral lands on the north shore of lake Superior, within the limits of this state, and also all other mineral or coal districts of the state, and the governor is hereby authorized to appoint a suitable person or persons to make such survey, whose report of the same shall be made to the governor, and by him transmitted to the Legislature.

Approved March 4, 1864.

GENERAL LAWS OF 1865, p. 84. *An Act to continue the geological survey of the mineral lands of the north shore of lake Superior.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That the governor be and is hereby authorized and empowered to appoint some suitable person to continue the geological survey of the mineral lands of the north shore of lake Superior, lying in the state of Minnesota, and also other mineral bearing districts within the limits of the state.

SEC. 2. Such person so appointed shall before entering upon his duties under the provisions of this act, take and subscribe an oath to diligently and faithfully discharge such duties to the best of his ability. And he shall proceed at as early a day as practicable to continue such survey under the direction of the governor. He shall make analysis of metal-bearing rocks that may be obtained during such survey, to the end that the commercial value thereof may be ascertained, and he shall report the same to the governor on or before the first day of January A. D. eighteen hundred and sixty-nine. He shall also make and report sectional maps showing the location of minerals examined and analyzed and as far as in his power, report upon the extent of the coal fields on the waters of the Big Cottonwood river, and the extent of such other mineral deposits as he may find, and such report shall be transmitted by the governor to the Legislature.

SEC. 3. The governor shall have power to draw from the state treasury out of moneys not otherwise appropriated, a sufficient amount to pay the actual and necessary expenses incurred by such person so appointed under the provisions of this act, not to exceed the sum of one thousand dollars.

SEC. 4. This act shall take effect and be in force from and after its passage.

Approved March 7, 1865.

GENERAL LAWS 1865, p. 85. *An Act to enable N. C. D. Taylor to continue the geological exploration of the country in the valley of the St. Croix, within this state.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That the sum of one thousand dollars be and the same is hereby appropriated and ordered to be set apart to N. C. D. Taylor out of any moneys in the treasury not otherwise appropriated, to enable him to continue the geological exploration of the country in the valley of the St. Croix, within this state, and that he report to the next Legislature the result of his labors.

SEC. 2. This act shall take effect and be in force from and after its passage.

Approved March 2, 1865.

GENERAL LAWS, 1866, p. 80. *An act to regulate mining upon the public lands of the United States, within the State of Minnesota.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. The miners and inhabitants of any section of this state in which there may be mines of gold, silver or other metals, upon the public lands of the United States for which patents have not been issued, may meet and form a mining district, not to exceed in extent five miles square, fix the boundaries, adopt a name, and pass such rules and regulations for such districts as may be deemed by them necessary for the location, holding, recording and working of mines or mining claims upon such public lands of the United States within such district. They may also elect a recorder for said district, and provide his qualifications, duties, fees and liabilities,

Provided. That no such mining claim shall exceed in extent two hundred feet square, and

Provided, further. That no such mining claim shall be made except by actual occupancy.

SEC. 2. On the trial of any action in any court of this state involving claim or the possession of any such mine or mining claim, or involving any right growing out of any such mine or mining claim; the rules and regulations so adopted in said district, or authenticated copies thereof, may be given in evidence, and so far as applicable shall govern the case.

SEC. 3. The term "mines" and "mining claims" as used in the preceding sections, shall be construed to embrace all water rights, ditches, flumes, timber claimed, or other interest appurtenant, necessary or auxiliary to a mine or mining claim, or the working thereof.

SEC. 4. The majority of the miners of such mining district, attending at a meeting, upon reasonable notice, may at any time change, alter, amend or repeal any of such rules and regulations previously adopted.

SEC. 5. This act shall take effect and be in force from and after its passage.

Approved March 2, 1866.

GENERAL LAWS, 1866, p. 98. *An Act to continue the geological survey of the State of Minnesota, and to appropriate money therefor.*

Be it enacted by the legislature of the State of Minnesota.

SECTION 1. Henry H. Eames is hereby appointed state geologist for the term of one year, commencing January 1st., 1866. He shall be commissioned by the governor, and it shall be his duty to continue the geological survey of the state, and prepare a report of such survey, subject to the provisions of section 2, chapter 39, of the general laws of Minnesota for 1865.

SEC. 2. The following sums of money are hereby appropriated out of any money in the state treasury not otherwise appropriated, for the prosecution of the geological survey for the year 1866.

For salary of state geologist, two thousand dollars, to be drawn monthly on the last day of the month.

For expenses of survey in mining districts and experiments on ores, and all incidental expenses of work, shall not exceed three thousand dollars, to be drawn upon the satisfactory vouchers of the state geologist, and accounts of expenditure to be furnished by him to the state auditor.

SEC. 3. The state geologist shall have his office in the capitol building, and shall there arrange and keep a collection of specimens of all minerals and such other interesting materials, which he may find in his explorations of the state. Said office shall be open to the public.

SEC. 4. The state geologist shall devote his time, labor and exertions exclusively for the benefit of the state at large, and shall afford no advantage whatever to any private enterprise or speculation.

SEC. 5. This act shall take effect and be in force from and after its passage.

GENERAL LAWS OF MINNESOTA, 1867, p. 40. *To regulate mining upon the public lands of the United States within the State of Minnesota.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That all mineral districts to be hereafter formed in this state shall conform to the township lines of six miles square.

SEC. 2. That all mineral claims shall be made in person by the party claiming, and any claim not thus made, is invalid.

SEC. 3. That when a mineral vein or lode or lead, containing gold, silver, cinnabar, or copper is discovered, the party making the discovery shall be entitled to two hundred feet on said vein or lode or lead as a discovery claim, with one hundred feet of land on either side of said vein, lode or lead, for its convenient working; and he shall also be entitled to an additional claim of two hundred feet on said vein, lode or lead, with one hundred feet of land on either side of said vein or lode or lead, for its convenient working, according to the act of congress, passed July 26, 1866.

SEC. 4. That to receive mineral claims the person making them shall measure off correctly, the number of feet allowed by law and shall post up a notice of said claim, of a substantial nature upon a stake or tree, at the end of every two hundred feet, upon which shall be written the name of the vein, with date of taking, name of claimant, number of claim and its general direction.

SEC. 5. That the claimant shall, within the three months from the time of posting up a notice of his claim, in compliance with the law, sink a shaft on said claim three feet deep by five feet square, and shall take from the bottom of the shaft so sunk, specimens of the rock, properly labelled, with the name of the vein, name of claim and name of claimant, thereon, number of claim, east or west, with a correct description of said claim, and file with the register of deeds of the county in which the mineral district is situated, and the register of deeds, after being satisfied that the said claimant has complied with the requirements of the law, and that he has not exceeded the two hundred feet, shall issue to said claimant and record the same, a certificate with description of claim, that said claim has been properly secured under the provisions of the law.

SEC. 6. That in case the claimant fails to sink a shaft three feet deep by five feet square, within the three months specified, then he shall forfeit all right to the claim, and any other party can come in and take possession.

SEC. 7. That whenever any citizen of the United States or those who have declared their intentions to become citizens, shall have complied with the provisions heretofore set forth, then they shall have rightful possessions of all claims made under and by virtue of this act for the space of one year from the date of the claim made, then all right and title to said claim shall be forfeited and another claimant may come in and take possession and secure a title under the law.

SEC. 8. That any person found tearing or mutilating any notice posted on any mineral claim in this state, shall be subject to arrest and imprisonment and on conviction, shall be fined not less than $50 nor more than $500.

SEC. 9. That the term "mineral claim," as used in the preceding sections, shall embrace all water rights, ditches, flumes, timber claimed, or other interest appurtenant, necessary or auxiliary to a mine or mining claim or the working thereon.

SEC. 10. That the fees of the register of deeds shall be as follows: Recording claim $1.00; transfer of claim 25 cents for each folio of one hundred words, and 25 cents for each certificate.

SEC. 11. That it shall be necessary to place in the hands of the register of deeds a description of each claim for record, within thirty days from the date of taking.

SEC. 12. That in case any mineral district in this state is located in an unorganized county, the claim shall be recorded in the organized county to which such unorganized county has been attached for judicial purposes, and the register of deeds of said organized county, shall perform the duties and receive the fees as provided by law.

SEC. 13. That it shall be the duty of all registers of deeds in counties where mineral claims are filed, to make a report every three months to the secretary of state of the number of claims taken, number of shafts sunk, and the general condition of the mines.

SEC. 14. This act shall take effect and be in force from and after its passage.

Approved March 6, 1867.

GENERAL LAWS, 1872, p. 86. *An Act to provide for a geological and natural history survey of the state and entrust the same to the University of Minnesota.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. It shall be the duty of the board of regents of the University of Minnesota to cause to be begun as soon as may be practicable, and to carry on a thorough geological and natural history survey of the state.

SEC. 2. The geological survey shall be carried on with a view to a complete account of the mineral kingdom as represented in the state, including the number, order, dip, and magnitude of the geological strata, their richness in ores, coals, clays, peats, salines and mineral waters, marls, cements, building stones and other useful materials, the value of said substances for economical purposes and their accessibility; also an accurate chemical analysis of the various rocks, soils, ores, clays, peats. marls and other mineral substances, of which complete and exact record shall be made.

SEC. 3. The natural history survey shall include, first, an examination of the vegetable productions of the state, embracing all trees, shrubs, herbs and grasses, native or naturalized in the state; second, a complete and scientific account of the animal kingdom as properly represented in the state, including all mammalia, fishes, reptiles, birds and insects.

SEC. 4. The said surveys and examinations shall be made in the manner and order following: first, the geological survey proper, together with the necessary and implied mineralogical investigations, all of which shall be undertaken so soon as may be practicable, and be carried forward with such expedition as may be consistent with economy and thoroughness; second, the botanical examinations; third, zoological investigations; *provided*, however, that whenever said board of regents may find it economical to prosecute different portions of the surveys in conjunction, or that the public interest demands it, they may, in their discretion, depart from the above prescribed order. And in the employment of assistants in the said surveys the said board of regents shall at all times give the preference to the students and graduates of the University of Minnesota, *provided* the same be well qualified for the duties.

SEC. 5. The said board of regents shall also cause to be collected and tabulated such meterological statistics as may be needed to account for the varieties of climate in the different parts of the state, also to cause to be ascertained [by] barometrical observations or other appropriate means the relative elevations and depressions of the different parts of the state; and also on or before the completion of the said surveys, to cause to be compiled from such actual surveys and measurements as may be necessary, an accurate map of the state, which map when approved by the governor, shall be the official map of the state.

SEC. 6. It shall be the duty of the said board of regents to cause proper specimens, skillfully prepared, secured and labelled, of all rocks, soils, ores, coals, fossils, cements, building stones, plants, woods, skins and skeletons of animals, birds, insects and fishes, and other mineral, vegetable and animal substances and organisms discovered or examined in the course of said surveys, to be preserved for public inspection free of cost, in the University of Minnesota, in rooms convenient of access, and properly warmed and lighted, ventilated and furnished, and in charge of a proper scientific curator; and they shall also, whenever the same may be practicable, cause duplicates in reasonable numbers and quantities of the above named specimens, to be collected and preserved for the purpose of exchanges with other state universities and scientific institutions, of which the Smithsonian Institute at Washington shall have the preference.

SEC. 7. The said board of regents shall cause a geological map of the state to be made, as soon as may be practicable, upon which, by colors, and other appropriate means and devices, the various geological formations shall be represented.

SEC. 8. It shall be the duty of the said board of regents, through their president to make, on or before the second Tuesday of December in each and every year, a report showing the progress of the said surveys, accompanied by such maps, drawings, and specifications as may be necessary and proper to exemplify the same to the governor, who shall lay the same before the legislature; and the said board of regents upon the completion of any separate portion of the said surveys shall cause to be prepared a memoir or final report, which shall embody in a convenient manner all useful and important information accumulated in the course of the investigation of the peculiar department or portion, which report or memoir shall likewise be communicated through the governor to the legislature.

SEC. 9. To carry out the provisions of this act the sum of one thousand dollars per annum is hereby appropriated to be drawn and expended by the [said] board of regents of the University of Minnesota.

SEC. 10. This act shall take effect and be in force from and after its passage.

Approved March 1, 1872.

GENERAL LAWS, 1873, p. 255. *An Act to aid the geological and natural history survey of the state and to amend chapter thirty-three of the general laws, approved March first eighteen hundred and seventy-two, authorizing such survey.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. The state lands known as "state salt lands," donated by the general government to aid in the development of the brines of the State of Minnesota, shall be transferred to the custody and control of the board of regents of the University of Minnesota. By said board of regents these lands may be sold in such manner, or in such amounts as they may see fit, the proceeds thereof being held in trust by them, and only disbursed in accordance with the law ordering a geological and natural history survey of the state.

SEC. 2. It shall be the duty of said board of regents, as soon as practicable, to cause a full and scientific investigation and report of the salt springs of the state, with a view to the early development of such brine deposits as may exist within the state.

SEC. 3. The board of regents of the University of Minnesota, shall cause the immediate survey and investigation of the peat deposits of the state of Minnesota, accompanied by such tests and chemical examinations as may be necessary to show their economical value, and their usefulness for the purpose of common fuel, a full report thereon to be presented to the legislature as soon as practicable.

SEC. 4. A sum of two thousand dollars is hereby appropriated annually (in lieu of one thousand dollars) for the purposes of the geological and natural history survey, until such time as the proceeds of the sales of the salt lands shall equal that amount, when such annual appropriation shall cease.

SEC. 5. The sum of five hundred dollars is hereby appropriated for the purchase of apparatus and chemicals for the use of the geological and natural history survey, the same to be expended by order of the board of regents of the University of Minnesota.

SEC. 6. It shall be the duty of the board of regents of the University of Minnesota, to cause duplicate geological specimens to be collected and to furnish to each of the three normal schools, suites of such specimens, after the University collection has become complete.

SEC. 7. When the geological and natural history survey of the state shall have been completed, the final report on the same by the said board of regents shall give a full statement of the sales of salt lands hereby given into the custody and control of the board of regents of the University of Minnesota, together with the amount of money, received therefrom, and of the balances, if any left in the hands of the said board of regents.

SEC. 8. This act shall take effect and be in force from and after its passage.

Approved March 10, 1873.

GENERAL LAWS, 1876, p. 44-46. *An act to authorize the formation of corporations for mining and smelting ores, and for manufacturing iron, copper and other metals.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. Any number of persons not less than three, desiring to form a corporation for the purpose of mining or smelting ores or minerals, or for both purposes, or for the purpose of manufacturing iron, steel, copper, or other metals, may do so upon complying with the provisions of this act; and any corporation so formed shall be entitled to the rights and privileges and be subject to the duties and obligations herein prescribed and shall have perpetual succession.

SEC. 2. Such persons shall sign and severally acknowledge articles of incorporation, which shall declare that they do thereby associate together and agree upon said articles, for the purpose of forming a corporation under the provisions of this act; and which said articles shall also contain.

First. The name of the corporation, which shall not be the same as that previously assumed by any other corporation in this state.

Second. The general nature of the business to be carried on, and the place of the principal office or headquarters of the company.

Third. The names and places of residence of the persons so associating to form such corporation.

Fourth. The amount of the capital stock of said corporation.

SEC. 3. Such articles shall be executed in duplicate, one of which shall be deposited for record in the office of the register of deeds of the county where said company shall establish its principal office, and the other with the secretary of state; and upon being so deposited, said corporation shall be deemed to exist under this act for the purposes specified in said articles, as a manufacturing and mechanical corporation, under the constitution and laws of this state, and may sue and be sued in the corporate name, and in such corporate name may contract and be contracted with, and transact and carry on the business mentioned in said articles, and may purchase, acquire, hold, use, sell transfer, convey, rent and lease all such real and personal property and effects as may be necessary or convenient for the purposes of said corporation. A certified copy of said articles from the said register of deeds, or from the secretary of state, shall be evidence in all courts of such corporation.

SEC. 4. The amount of capital stock of any such corporation shall in no case be less than ten thousand dollars, nor more than two million five hundred thousand dollars, and shall be divided into shares of twenty-five dollars each, and each share shall be entitled to one vote at any meeting of the stockholders, and may be represented by the holder thereof in person, or by his proxy, under written appointment. The capital stock may be increased by a majority vote of the stockholders at any regular meeting thereof, but not so as to exceed said maximum amount.

SEC. 5. Such corporation may prescribe and adopt by-laws for the management of its business and affairs, by a board of directors, trustees, committee or other officers or agents, and provide for their election or appointment, and prescribe their duties, and may require bond from any officer for the faithful discharge of duties, and may by such by-laws prescribe in respect to all matters appertaining to the business and affairs of said corporation, not inconsistent with the provisions of this act, nor the constitution or laws of this state. Such by-laws may be made, altered or amended by the directors, trustees or committee clothed with the general management of the affairs of such corporation, but the stockholders, at any regular meeting, may repeal or alter any by-laws, or adopt new ones, and such action shall remain binding until repealed or changed by the stockholders themselves at some regular meeting. Such corporation shall keep a record of all proceedings had at meetings of stockholders, and also of all proceedings had or taken by the board of directors, trustees, or committee having charge of its affairs, and such record shall be subject to the inspection of all stockholders at all reasonable times. A copy of all by-laws, duly certified, and all amendments and alterations of the same, shall be filed for record with the register of deeds where said articles of incorporation are recorded, and also with the secretary of state, and shall not become operative or valid until so filed. Until otherwise provided, the persons executing such articles of incorporation shall constitute a board of directors, with full power and authority to make by-laws and manage the affairs and business of such corporation.

SEC. 6. The stock of any such corporation shall be deemed personal property and may be issued, sold and transferred as may be prescribed by resolution or by by-laws of said corporation or its managing board, but no stock so issued or sold, purporting to be full paid, shall be subject to any further assessment in the hands of the lawful holder thereof, without his consent. Upon the issuance of stocks the lawful holders thereof shall constitute the members of such corporation, and a majority in amount thereof may call a meeting of the stockholders at any time, irrespective of any by-laws, at the principal office of the company, or at the capital of the state, upon giving thirty days notice by publication in a newspaper published at the place of such office, if there be such paper, and if not, then a paper published at the capital.

SEC. 7. The directors or managing officers of any such corporation may meet and transact business without this state, as may also the stockholders, by by-laws therefor; and offices may be established without this state. *Provided*, that an office shall always be maintained in this state, where legal processes may be served on such corporation, and such service upon an officer or director, if personally made, shall be deemed personal service upon the corporation.

SEC. 8. Any corporation organized under this act for the purpose of mining ore which has to be smelted or otherwise treated to extract the metal, may take, acquire, and hold stock in another corporation organized for the purpose of smelting or otherwise extracting the ore, if a majority of the stock holders shall so elect.

SEC. 9. Such corporation may mortgage its property, or any part thereof, by a vote of a majority of its stock, but not otherwise; and no real estate of any such corporation, or any interest therein, shall be sold, leased or conveyed, without the consent of a majority, in amount, of the stockholders.

SEC. 10. Any officer of any corporation organized under this act, or any other person or persons who shall fraudulently issue, or cause to be issued, any stock, scrip or evidence of debt of such corporation, or who shall sell, or offer for sale, hypothecate or otherwise dispose of any such stock, scrip or other evidence of debt knowing the same to be so fraudulently issued shall be deemed guilty of felony, and on conviction thereof, shall be imprisoned in the state prison not more than ten nor less than one year.

SEC. 11. This act may be altered or amended at the pleasure of the legislature, but not so as to divest or impair any right of property acquired under the same.

SEC. 12. This act shall take effect and be in force from and after its passage.

Approved February 24, 1876.

GENERAL LAWS, 1881. *An Act to encourage mining in this state by providing a uniform rule for the taxing of mining property and products.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That all corporations now organized or that may be hereafter organized under the laws of this state for the purpose of carrying on the business of mining, smelting or refining copper or iron ores, or for the purposes of mining coal within the state, may pay into the state treasury annually, on or before the first day of January in each year, in lieu of all taxes or assessments upon the capital stock, personal property, income and real estate of such corporation, in or upon which real estate such business of mining may be carried on, or which real estate is connected therewith and set apart for such business, the following amounts, that is to say: on and for each ton of copper fifty (50) cents; on and for each ton of iron ore mined and shipped or disposed of, one cent for each ton; and for each ton of coal mined the sum of one cent per ton; each ton to be estimated as containing two thousand two hundred and forty (2,240) pounds; one-half of such payments to be credited to the general fund of the state, and the other half credited to the county or counties in which such mines are located.

SEC. 2. That it shall be the duty of each and every corporation accepting the provisions of this act to make return in writing, and report to the state auditor, on or before the fifteenth (15) day of December in each year, a true and full statement of each and every ton of copper or iron ore or coal mined and sold or disposed of during the year preceding the date of such return; which statement shall be verified by the oath of the president and secretary of such corporation. That any such officer who shall knowingly make or sign any false and untrue statement in such report or return, shall be deemed guilty of perjury and on conviction thereof shall be punished as provided in chapter twenty-seven (27) of of the general statutes of 1878.

SEC 3. That any corporation now organized under the laws of this state, or that may hereafter be organized therein for the purpose of mining, smelting or refining copper or iron ores, or for mining coal, may, by resolution duly adopted by its board of directors, accept all the provisions of this act, and that upon the filing of a certified copy of such resolution of acceptance in the office of the secretary of state for this state, such corporation shall be bound by the provisions of this act, and thereafter be entitled to all the benefits thereof.

SEC. 4. This act shall take effect and be in force from and after its passage.

Approved November 22, 1881.

SPECIAL LAWS.

(1849-75, INCLUSIVE.)

Mining Companies.

Great Western Mining Company of Pennsylvania, 1870, p. 444.
Boston and Minnesota, 1855, p. 111 ; 1866, p. 230.
Minnesota, 1856, p. 248 ; 1868, p. 409 ; 1869, p. 357.
North Shore, 1857, p. 212.
Pittsburg and Minnesota, 1855, p. 156 ; 1856, p. 107 ; 1864, p. 353.
Lake Superior and Puget Sound, 1871, p. 368.

Belle Plain Salt Company.

1870, pp. 424-421; 1871, p. 365 ; 1872, p. 428.

Minnesota Salt Company.

1856, p. 176 ; 1870, p. 421.

SPECIAL LAWS, 1855, p. 156. *An act to incorporate the Pittsburg and Minnesota Mining Company.*

SECTION 1. The corporators and their powers and liabilities under this charter.

SEC. 2. Limitation of the capital stock which is declared personal property.

SEC. 3. Rights and privileges to be enjoyed by the company and its power over lands.

SEC. 4. Stock to be deemed personal property, and transferable only on the books of the company.

SEC. 5. How and by whom the property of the corporation shall be controlled.

SEC. 6. Of the time and manner of electing directors.

SEC. 7. When this act shall take effect.

SEC. 8. The county of Carver declared organized, and the election of officers authorized until whose election the said county is attached to Hennepin county for judicial purposes.

SEC. 9. This act declared a public act.

SEC. 10. Power to modify and to amend reserved.

Approved March 3, 1855.

Special Laws, 1855, p. 111. *An Act to incorporate the Boston and Minnesota Mining company.*

Section 1. Corporate name, the Boston & Minnesota Mining company—its seal, the manner of electing its officers and the establishment of by-laws.

Sec. 2. Capital stock and shares of the company.

Sec. 3. The rights and privileges to be enjoyed by the company.

Sec. 4. The stock of the company declared personal property.

Sec. 5. The affairs of the corporation to be managed and conducted by a board of not less than three nor more than seven directors, who shall decide the manner and proportions in which stock shall be paid in.

Sec. 6. Of the place and manner of electing directors.

Sec. 7. When this act shall take effect.

Sec. 8. This act declared a public act.

Sec. 9. The right to modify and amend reserved.

Approved March 3, 1855.

Special Laws of Minnesota, 1856, p. 176. *An Act to incorporate the Minnesota Salt Company.*

Section 1. Names of corporators and name and style of company.

Sec. 2. Rights and privileges of corporators.

Sec. 3. Stock not to exceed $500,000.

Sec. 4. Number and power of board of directors.

Sec. 5. In force on and after passage.

Sec. 6. Subject to legislative alteration.

Approved February 20, 1856.

Special Laws, 1856. *An Act to revive, amend and continue an act entitled, "An Act to incorporate the Boston and Minnesota Mining Company," approved March 30, 1855, and to revive the corporation thereby created.*

Section 1. Revives act of Territorial Assembly relative to Boston Mining Company.

Sec. 2. Amends section one of said act, by naming certain parties to constitute the corporation.

Sec. 3. When act to take effect.

Approved March 3d, 1855.

Special Laws, 1856, p. 248. *An Act to Incorporate the Minnesota Mining Company.*

Section 1. Names of corporators, created body corporate.

Sec. 2. Rights and privileges of corporation.

Sec. 3. Amount of capital stock.

Sec. 4. Affairs, by whom managed.

Sec. 5. By-laws to provide for election.
Sec. 6. Sum to be paid into the territorial treasury.
Sec. 7. To continue in force twenty years.

Approved Feb. 25, 1856.

Special Laws, 1868, p. 409. *An act to amend chapter 149, of the Session Laws of 1856, entitled "An Act to Incorporate the Minnesota Mining Company.*

Section 1. Board of Incorporators, name and style of said company to be Minnesota Mining Company.

Sec. 2. To enjoy all rights and privileges incident to a mining corporation.

Sec. 3. Capital stock not to exceed one million dollars in one hundred dollar shares.

Sec. 4. Property to be managed by a board of directors elected annually.

Sec. 5. Date and place of elections, second Monday in March, in Minneapolis.

Sec. 7. President, etc., to be chosen by the board of directors and all certificates of stock or shares to be signed by president and countersigned by secretary under seal of the company.

Sec. 8. Act to be in force fifty years, but may be amended by the legislature after ten years.

Sec. II. Books for subscription to be opened in Minneapolis on the second Monday of March, 1868.

Sec. III. Act to be in force from and after its passage.

Approved March 5, 1868.

Special Laws, 1868, p. 357. *An Act to amend Section one, of chapter one hundred and seventeen, of the Special Laws of the year 1868, relating to the Minnesota Mining Company.*

Sec. 1. Name changed to "Burnt Rock Mining Company" and vested with the usual obligations and privileges.

Approved March 3, 1869.

Special Laws, 1870, p. 421. *An Act to aid the Belle Plaine Salt Company in the development of Salt Springs at Belle Plaine.*

Sec. 1. Grant of six sections of land to.

Sec. 2. Expenditure of the amount of $1600 entitles the company to one section of land till six such amounts have been expended.

Sec. 3. Such lands not to be sold by the company for less than $2.50 per acre; such rates to be reported to the governor. The company to be liable to the state for all money so procured not invested in carrying on business.

SEC. 4. A duty of one cent per bushel of manufactured salt, till an aggregate sum shall have been so paid equal to the value of such lands received at $2.50 per acre.

SEC. 5. The state reserves the right to impose any duty upon the product of salt springs, which may be discovered upon such lands granted.

SEC. 6. Any authorized officer may administer the necessary affidavits or oaths.

SEC. 7. To be in effect from and after its passage.

Approved Feb. 28, 1870.

SPECIAL LAWS, 1870, p. 424. *An act to amend the above act.*

SEC 1. Amends Sec. 5 of Chap. 114 special laws of 1870. All liabilities and obligations to the state which the said company shall be under or may assume, shall attach to assigns or representatives in case of sale or transfer.

Approved March 4, 1870.

SPECIAL LAWS, 1870, p. 444. *An Act authorizing the Great Western Mining Company of the State of Pennsylvania, to transact business in this state.*

SECTION 1. Said company authorized to purchase and hold real estate necessary to carry on the business of mining in this state.

SEC. 2. To appoint a resident agent in this state at Thompson City, upon whom service of process may be made.

SEC. 3. To be in force from and after its passage.

Approved March 1, 1870.

SPECIAL LAWS, 1871, p. 368. *An Act to further aid the Belle Plaine Salt Company in the development of salt springs at Belle Plaine.*

SECTION 1. Six additional sections of "salt lands" upon the same conditions as above, *provided* that the favorable opinion of some competent geologist, to be appointed by the governor, shall be secured.

SEC. 2. To be in force from and after its passage.

Approved March 6, 1871.

SPECIAL LAWS, 1871, p. 365. *An Act authorizing the Lake Superior and Puget Sound Company of the State of Maine to transact business in this State.*

Such powers are granted as are necessary for the purpose of carrying on its business.

An agent to be appointed at Crow Wing.

SPECIAL LAWS, 1882, p. 428. *An Act granting to the Belle Plaine salt company land in aid of the work of said company.*

Be it enacted by the Legislature of the State of Minnesota.

SECTION 1. That six sections of the "salt lands" of the state are hereby granted to the Belle Plaine salt company, for the purpose of aiding the same in the continuance of its work, upon the terms and conditions hereinafter named.

SEC. 2. Whenever the said company shall have bored to the depth of two hundred feet below the bottom of the present bore or well, the said company shall be entitled to a conveyance of two sections of said land, and whenever said company shall have bored to the further depth of two hundred feet, or four hundred feet from the bottom of its present bore or well, the said company shall be entitled to a conveyance of two additional sections of said land, and whenever the said company shall have bored to the depth of five hundred feet from the bottom of the present bore, the said company shall be entitled to a conveyance of of the other two sections of said land. Upon proof satisfactory to the governor that said company has fulfilled the terms and conditions entitling the same to any installment of said lands, the governor shall certify that fact to the state auditor, and upon filing such certificate together with a certificate signed by the president and secretary of said company, that the lands described therein have been selected by the said company under the grant made by this act, in the office of the state auditor, he shall receive and record the same, and thereupon the title to the lands so selected shall vest in the said company, which shall thereby become and be the owner thereof in fee.

Provided, however. That in making the said selections of said lands the said company shall not be allowed to select the whole or any part of any section of land on which any of the salt springs selected by the state is located, or more than three sections selected and located by the state as applicable or appurtenant to any one spring.

SEC. 3. Should the said company get through the rock at less than five hundred feet below the bottom of the present well, and there find salt deposits of sufficient strength to be profitably worked, and should cease boring therefor, and that fact be proven to the satisfaction of the governor, the said company shall receive a pro rata proportion of the said lands—upon such proof the governor shall certify the fact to the state auditor, which certificate, with a certificate of the said company, filed and recorded in the office of the state auditor as aforesaid, shall vest the title of the lands so selected in said company as herein before provided.

SEC. 4. This act shall take effect and be in force from and after its passage.

Approved February 29, 1872.

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PLATE 1.

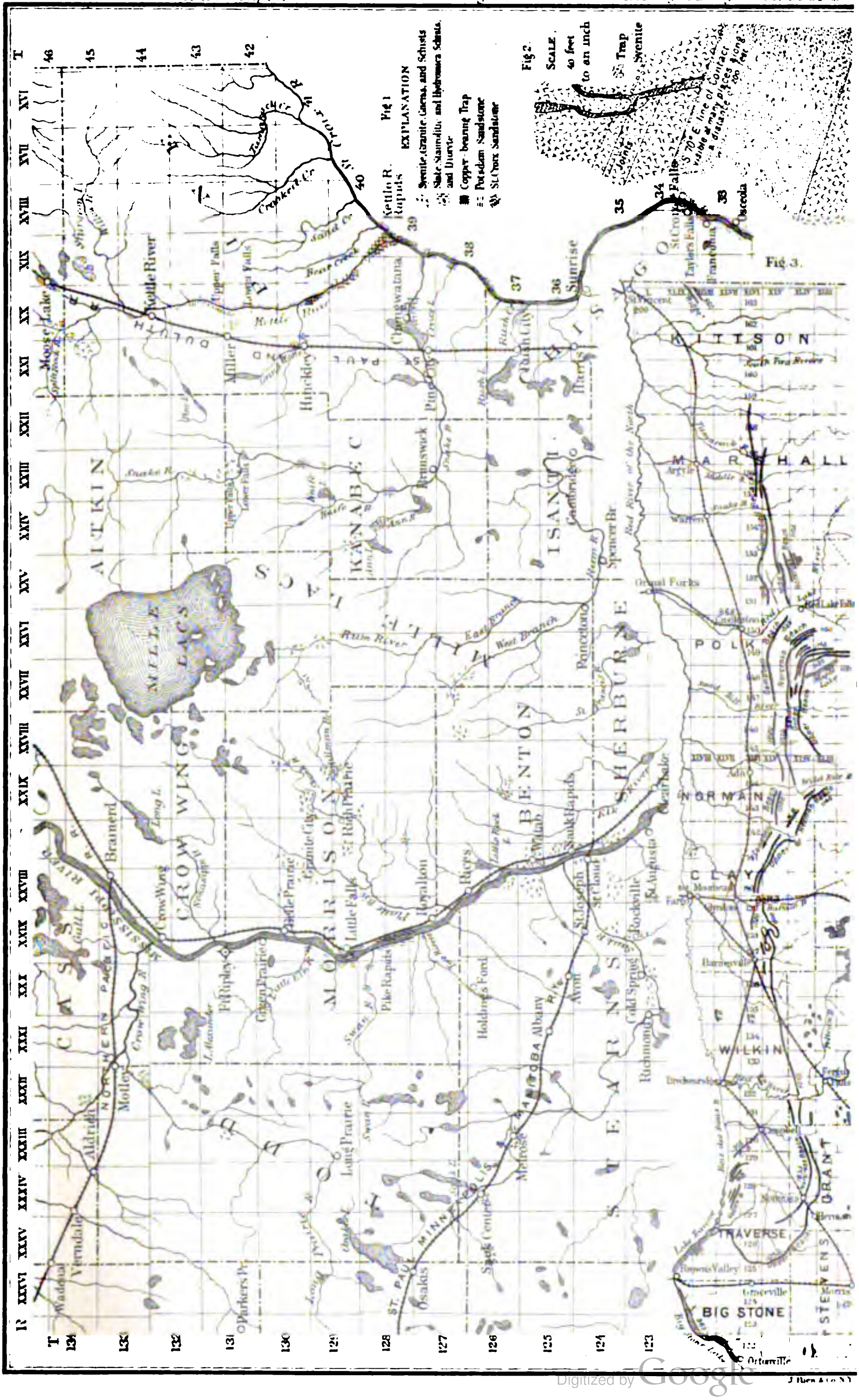
Fig. 1. Map showing rock-outcrops in central Minnesota.

Fig. 2. Dikes of trap in syenite, sec. 28, T. 134, R. 32 (see page 88).

Fig. 3. Beaches of lake Agassiz.

By Warren Upham.

PLATE I. 11th Annual Report Geological and Natural History Survey of Minnesota



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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

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THE FIRST ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1872. 112 pp., 8vo.; with a colored map of the state. By *N. H. Winchell*. Published in the Regents' Report for 1872. Out of print.

THE SECOND ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1873. 145 pp., 8vo.; with illustrations. By *N. H. Winchell* and *S. F. Peckham*. Published in the Regents' Report for 1873. Out of print.

THE THIRD ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1874. 42 pp., 8vo.; with two county maps. By *N. H. Winchell*. Published in the Regents' Report for 1874. Out of print.

THE FOURTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1875. 162 pp., 8vo.; with four county maps and a number of other illustrations. By *N. H. Winchell*, assisted by *M. W. Harrington*. Also in the Regents' Report for 1875.

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THE SIXTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1877. 226 pp., 8vo.; three geological maps and several other illustrations. By *N. H. Winchell;* with reports on Chemical Analyses by *S. F. Peckham,* on Ornithology by *P. L. Hatch,* on Entomology by *Allen Whitman,* and on Geology of Rice county by *L. B. Sperry*. Also in the Regents' Report for 1877. Out of print.

THE SEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1878. 123 pp., 8vo.; with twenty-one plates. By *N. H. Winchell;* with a Field Report by *C. W. Hall,* Chemical Analyses by *S. F. Peckham,* Ornithology by *P. L. Hatch,* a list of the Plants of the north shore of Lake Superior by *B. Juni,* and an Appendix by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota (twenty-one plates). Also in the Regents' Report for 1878.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 183 pp., 8vo.; one plate (Castoroides). By *N. H. Winchell*. Containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, and descriptions of new species of brachiopoda from the Trenton and Hudson River formations; with reports on the Geology of Central and Western Minnesota, by *Warren Upham;* on the Lake Superior region, by *C. W. Hall;* lists of Birds and of Plants from Lake Superior, by *Thomas S. Roberts;* Chemical Analyses by *S. F. Peckham;* report by *P. L. Hatch;* and four Appendixes. Also in the Regents Report for 1879 and 1880.

THE NINTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1880. 392 pp., 8vo.; three appendixes, two wood cut illustrations, and six plates. By *N. H. Winchell.* Containing field descriptions of 442 crystalline rock samples, and notes on their geological relations, from the northern part of the state; new brachiopoda; the water supply of the Red River Valley, and simple tests of the qualities of water; with reports on the Upper Mississippi region, by *O. E. Garrison;* on the Hydrology of Minnesota, by *C. M. Terry;* on the Glacial Drift and its Terminal Moraines, by *Warren Upham;* Chemical Analyses by *J. A. Dodge;* a list of the Birds of Minnesota, by *P. L. Hatch;* and of the Winter Birds, by *Thomas S. Roberts.* Also in the Regents' Report for 1879 and 1880.

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II. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. A copy of the law ordering the survey, and a note asking the co-operation of citizens and others. 1872.
2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham.*
3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. A history of all official transactions relating to them, and a statement of their amount and location. 1874. By *N. H. Winchell.*
4. A CATALOGUE OF THE PLANTS OF MINNESOTA; prepared in 1865 by *Dr. I. A. Lapham,* contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.
5. CIRCULAR No. 2. Relating to Botany, and giving general directions for collecting information on the flora of the state. 1876.
6. CIRCULAR No. 3. The establishment and organization of the Museum. 1877.
7. CIRCULAR No. 4. Relating to duplicates in the Museum and exchanges. 1878.
8. THE BUILDING STONES, LIMES, CLAYS, CEMENTS, ROOFING, FLAGGING, AND PAVING STONES OF MINNESOTA. A special report by *N. H. Winchell,* 1880.
9. CIRCULAR No. 5. To Builders and Quarrymen. Relating to the collection of two-inch cubes, of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum. 1880.
10. CIRCULAR No. 6. To owners of mills and unimproved water-powers. Relating to the Hydrology and water-powers of Minnesota. 1880.

5

Russell

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

THE TWELFTH ANNUAL REPORT,

FOR THE YEAR 1883.

N. H. WINCHELL, STATE GEOLOGIST.

MINNEAPOLIS:
JOHNSON, SMITH AND HARRISON,
STATE PRINTERS.
1884.

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1884.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., DECEMBER 1, 1883.

To the President of the University:

DEAR SIR:—I herewith tender the twelfth annual report on the progress of the geological and natural history survey of the state. I include herewith a copy of the first annual report for reprint, that report being in constant demand, and out of print now for several years.

Very respectfully, your obedient servant.

N. H. WINCHELL,

State geologist and curator of the general museum.

151506

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REPORT.

I.

SUMMARY STATEMENT.

The greater portion of the time during the year has been given both by Mr. Upham and myself to the final revision of manuscript for the printers, and the reading of proofs, the preparation of maps, plates and other illustrations, and the proofs of the same, intended for the final report. At the present time the following county maps have been drawn, lithographed and printed, showing the geology and surface features, and the lines of equal elevation above the sea, viz: Houston, Winona, Fillmore, Olmsted, Mower, Dodge, Freeborn, Waseca, Steele, Blue Earth, Faribault, Watonwan, Martin, Cottonwood, Jackson, Murray, Nobles, Pipestone, Rock, Lincoln, Lyon, Yellow Medicine, Redwood, Brown, Nicollet, Le Sueur, Wabasha, Scott, Carver, Wright, Lac qui Parle and Big Stone. The counties of Goodhue, Rice and Dakota, and several others, are in course of preparation, and sufficient examination has been made in nearly all the state as far north as Brainerd, for mapping and reporting in the same manner. In the northern half of the state, also, much information has been obtained. Considerable more work, however, must be done in that portion north of the parallel of Brainerd, where the difficulties of travel increase, and at the same time the geology becomes more difficult and more interesting. Should the survey continue according to the present design, the system of mapping, and of description now being carried on, could be extended over the rest of the state with the present force in about two years. But as the printing of work already prepared, and the preparation of maps and manuscript for future publication, require much time, the completion of the survey cannot be looked for before the close of the fourth year from this date. In addition to this, other matters demanded by the law of the survey are very important, but have been kept in abeyance pending the completion of the strictly geological portion. This will require further time and other workmen. It is to be hoped that the regents will always be able to make an annual increment to the scientific knowledge of the state, in some of the departments of investigation covered by the law of the survey, and that the annual reports will successively become more and more valuable as they become more numerous.

Dr. P. L. Hatch, who has charge of the investigations in the ornithology of the state, has signified his intention to render his final report on the same by or before the spring of 1885.

Mr. C. L. Herrick has been given the mammalogy of the state, with a view to the collection of skins and skeletons for the museum, and the preparation of a final report on the same for publication in about two years.

The only field-work done in 1883, was that performed by myself in Dakota and Rice counties, including, however, further supplementary observations in Mower and Olmsted counties, and a visit to some of the localities of red quartzyte in the southwestern part of the state.

Additional cases will soon be placed in the south room of the museum, intended for the reception of the collections of Dr. H. C. Hovey, representing the stalactitic deposits of caves. This valuable collection has kindly been loaned to the University, on deposit, with the only condition that it shall be well kept.

Further additions have been made to the specimens belonging to the general museum, through the agency of the survey, and by donation by the following individuals: W. H. Scofield, of Cannon Falls, and James B. Alexander, of Minneapolis, and by several others.

These are all enumerated in the accompanying list of accessions. Exchanges have been made with A. S. Tiffany, of Davenport, Iowa, and John Eyerman, of Carbondale, Pennsylvania.

The final paper of Mr. Herrick on a portion of the *Crustacea* of Minnesota is presented in this report, illustrated by a number of octavo plates.

The intent of the circular issued in 1876* respecting the botany of the state has been kept in mind. Several correspondents have contributed both information for a catalogue of the species of the state, and specimens for the University herbarium. During the past two years Mr. Upham has been engaged, casually, in the preparation of such a catalogue. There has been considerable request for a more complete listing, and a more full account of the distribution of the plants of the state, than that of Dr. I. A. Lapham, published by the Minnesota Horticultural Society in 1875. The very complete catalogue, prepared by Mr. Upham, is herewith transmitted as a part of this report. It includes and classifies all reliable information on the botany of the state that is now in the possession of the survey, and will serve as a more useful guide to students and others in the future study of species and their distribution in Minnesota, than anything hitherto published.

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*See the fifth annual report, p. 64.

II.

PALÆONTOLOGY.

(a)

A NEW TRILOBITE.

In the registration of specimens lying in the university building in 1873, a lot of miscellaneous rocks, minerals and fossils was found that had been presented by the late Dr. Stoneman, of Minneapolis. The fossils and rocks were evidently from the Trenton at Minneapolis; but as there were no certain records respecting them, they were all entered in the register, and finally published, with the note "records doubtful." (*Fifth annual report*, p. 207.) A slab of fossiliferous limestone (Mus. reg. number 90) was thus referred to the Trenton. In the sixth annual report a fossil trilobite, contained on this limestone, was reported after a casual examination as Asaphus extans, of Hall (*loc. cit.* p. 161), with the remark that it "has a tuberculated surface instead of lamellose."

In March, 1879, at the request of Lieut. A. W. Vogdes this specimen was sent to him, and he kindly returned the specimen with the following description, as a new species, naming it in honor of Dr. Stoneman.

Bathyurus Stonemanii, Vogdes.

Description.—The pygidium is semi-elliptical, strongly convex, and the width a little greater than the length. The anterior margins are rounded, and the outer margins bordered by a well-defined convex limb. The axis is greatly elevated above the sides, and tapers toward the posterior margin, terminating on the limb. The axis is marked with six rings, the first three being well-defined, and the others not so prominently marked. The dorsal furrows are deep and well-defined. The lateral lobes are convex and have five pleuræ, each being separated by deep furrows. The pleuræ are bent downward and backward, and arise from the second, third, fourth and fifth axial rings. They all terminate upon the inside furrow which outlines the limb. The points of termination of the anterior pleuræ are on a line with the fifth axial ring. The entire pygidium is bordered by a convex limb which runs from the fulcral points around it. This limb has an inside furrow which runs between the termination of the axis and the limb, and also an exterior furrow.

The surface of the upper dorsal shell is tuberculated.

Locality and geological position. The Trenton group, probably at Minneapolis, Minn. Presented to the general museum by Dr. Stoneman.

This species approaches B. senectus, Billings, which has six axial rings and four pleuræ. Our species is, however, much larger, and has a greater member of pleuræ. The inside marginal furrow in the former species does not extend all around the pygidium, but ends abruptly at the end of the axis. Billings' species comes from the Potsdam group, and ours from a different geological position. Our species has certain affinities with B. extans, Hall. The most prominent points of difference between the former and that described by Prof. Hall is that the axis is more elevated, and does not terminate so abruptly behind in B. Stonemanii. The second dorsal surface of B. extans is marked with fine imbricating lamellose striæ, whereas our species is tuberculated.

There are three species of this genus described, which appear in the Trenton group; viz. B. extans, H.; B. longispinus, Walcott; and B. spiniger, H. Of all the species, with the exception of the last named, the pygidium is known, and differs from our species. The only part of B. spiniger, H. known to us is the glabella, which is tuberculated; and there is reason to suppose that our species may be the missing part of B. spiniger; but it is doubtful.

The geological range of the genus is from the Potsdam to the Trenton group.

(b)

THE AGE OF THE SANDROCK AT AUSTIN, MOWER COUNTY.

On page 360, of the first volume of the final report of the survey, the age of the sandrock at Austin is considered, and Prof. H. S. Williams is referred to as authority for identification of some fossils from that rock. In justice to Prof. Williams the full text of his communication relating to these fragmentary fossils is herewith given. If the horizon of the Austin rock be in the Marcellus shale, the overlying limestones appearing in the Cedar valley near the state boundary, and further south, probably all fall into the Hamilton epoch.

Letter of professor H. S. Williams.

ITHACA, N. Y. Sept. 14, 1883.

My dear professor:

I have examined the fossils which you sent me and enquire particularly about in your letter received a few days ago. The fossils are in very imperfect condition; and the identification cannot be regarded as anything more than strongly probable.

I find in the lot, No. 2699, from Gregson's mill, these species.

1. Productella truncata, Hall.
2. A minute lamellibranch, like a small Aviculopecten.
3. A minute brachiopod; oval, the smooth surface resembling a dorsal valve of Ambocælia, or (?) a Nucleospira.

The second lot, No. 2698, Cedar valley, Mower county, resembles lithologically the first, but the fossils are distinct. They are:

1. Numerous cavities of Aulopora, or some allied form.
2. A small shell like Atrypa reticularis.
3. A small shell like Atrypa aspera.
4. Cyrtina, like C. Dalmani, but may be C. Hamiltonensis.
5. Several lenticular-shaped shells which are probably Nucleospira.
6. A minute terebratuloid shell of Rensselæria type.
7. Trace of a crinoid stem.
8. Trace of a minute Orthoceras, or (?) Coleolus.

You ask my opinion of the horizon. The material is very unsatisfactory for basing a judgment on; but if the two lots are from the same horizon, it is safe to say that it is lower Devonian.

Taking the fauna of No. 2698 alone, I see nothing to prevent its being Upper Silurian.

If the two lots are from the same rock, I should think from study of the fossils that the horizon is not higher than the base of the Hamilton period, nor lower than the Lower Helderberg; and my opinion is that the fauna belongs to an horizon near the base of the Hamilton, either below it or in an equivalent position to the New York Marcellus. The only really satisfactory fossil is the Productella truncata; and if the brachiopods of No. 2698 came from a stratum under that containing No. 2699, the No. 2698 lot might occur anywhere from the Hamilton down to the Lower Helderberg.

Nucleospira, Rensselæria type of terebratuloids, Cyrtinas and Atrypas are genera passing from Upper Silurian through lower and middle Devonian, and generally do not mark any narrow geological horizon.

From their association, and the fact that they are all minute specimens, I should conclude that it was a sparse fauna in unfavorable conditions of life, which might have lived anywhere along the Upper Silurian or lower Devonian. But the Productellas are peculiar to Devonian and above.

Have you not found any more fossils? I should think a careful search might bring out specimens that could be determined accurately; and it would be interesting to have the means of determining the species.

I wish I could speak more definitely; but this is the best I can do with the specimens. Possibly this with the stratigraphical study may enable you to fix the horizon.

With sincere regard,

HENRY S. WILLIAMS.

(c)

CRETACEOUS LEAVES. PRELIMINARY STATEMENT OF DR. LEO LESQUEREUX.

The Cretaceous leaves that have been obtained in the state from the Cretaceous strata at various times and places, have been submitted to Mr. Lesquereux for determination and description. His final report will appear subsequently, but the following is the result of a preliminary examination of a lot of specimens sent.

Dr. Lesquereux' preliminary report.

The content of the lot, received Jan. 14th, 1884, is as follows:

No. 2143.	From the north side of the Minnesota river, eight miles below New Ulm, represents 4 small undeterminable fragments of leaves, without trace of nervation. No. 2143 (A) is apparently a *Proteoides*.
No. 3808 and 5163.	*Ficus*, sp. nov. No. 5163 is not marked in the list; it is labelled *Austin*.
No. 3911.	*Laurus Nebrascensis*, Lesq., 1 leaf on three pieces.

No. 3912.	*Salix proteæfolia,* Lesq. The above three Nos. are from the north side of the Cottonwood river in Brown county.
No. 5155 (A).	*Populus litigiosa,* Heer, and Cinnamomum Scheuchzeri, Heer, on the reverse.
No. 5155 (B), 5155 (H), 5157 (B).	*Magnolia alternans*, Heer.
No. 5155 (C).	*Populus elegans*, Lesq.
No. 5155 (D).	" *Lancastriensis*, Lesq., (probably equivalent to P. cordifolia, Newby).
No. 5155 (F).	*Protophyllum crednerioides*, Lesq.?, a fragment; base of leaf destroyed.
No. 5155 (G, K).	*Populites cyclophyllus*, Lesq.
No. 5155 (I).	2 fragments of superposed leaves, the lower only distinct, *Cinnamomum Scheuchzeri*, Heer.
No. 5155 (L, M, O).	*Populus litigiosa*, Heer, 3 specimens.
No. 5155 (P).	*Populus cyclophylla*, Lesq, a deformed plicate leaf.
No. 5155 (Q & S)	2 fragments of the same leaf, *Platanus primæva*, Lesq., with a leaf of *Persea?*, not yet satisfactorily determined, upon 5155 (S).
No. 5155 (E, N, R).	3 undeterminable fragments.
No. 5156.	*Cissus*, sp. nova; name not yet fixed.
No. 5157 (C).	*Salix proteæfolia*, Lesq., with a branch of Platanus on the reverse.
No. 5157 (A).	*Andromeda Parlatorii*, Heer.
No. 5158.	*Laurus*, sp. nov., not yet named.
No. 5159.	Fragment of undeterminable leaf, areolated by maceration, *Ficus??*.
No. 5160.	Leaf of *Pinus*, sp. nov., not yet named.
No. 5161.	No vegetable remains, but shell or some animal organism. The osseous plate marked by striæ is 2 mm. thick. I have seen along the banks of the Cottonwood river, above the Cretaceous sandstone bearing leaves, large fragments of shells as thick as the plate upon 5161.
No. 115.	*Sequoia*, sp. nov., a specimen which I have already seen here. It bears the label Austin, Minn.

As far as I can see now, the specimens remarked above, 36 in number, represent 16 species, of which 4 are new ones. Of the species, 10 have been recognized in the Dakota group of Kansas and Nebraska, and two in the same Cretaceous formation of Colorado.

The specimens No. 5155 A, down to the end of the list except No. 115, are all from the Cottonwood river, about 3 miles south of New Ulm. They have one species in common with those of the north side of the same river in Brown county, where-from 3 specimens only are sent.

The whole lot is valuable and interesting. One quarto plate would suffice for the figures of the more interesting species and best specimens.
L. LESQUEREUX.

Columbus, O., Jan. 17th, 1884.

III.

THE COMPARATIVE STRENGTH OF MINNESOTA AND NEW ENGLAND GRANITES.[1]

By N. H. WINCHELL.

Having had occasion recently to investigate the qualities of some of the building-stones of the state of Minnesota, I found it necessary to subject them to the usual test of *crushing*, in the form of two-inch cubes, to learn their strength under pressure.

Samples were obtained and dressed to the required size by Mr. William Keating, at the marble shops of Messrs. Sullivan and Farnham, in this city. About one hundred of such cubes were formed, embracing sandstones, limestones, granites and trap rocks. It is intended in this paper to show the remarkable, and unexpected strength exhibited by the crystalline rocks of the state, and especially their superiority in that respect over the granites of New England.

The samples as prepared were carefully chosen to avoid flaws and imperfections due to weathering. They were dressed by hand with hammer and chisel on all six sides, so as to measure two inches on all their edges, the sides all being exact squares. They were sent to Gen. Gillmore, at Fort Wadsworth, Staten Island, where they were subjected to the test for crushing-strength in the same manner as many other granites that have been tested and reported by him in his reports to the chief of engineers, from other portions of the United States and particularly from New England. The tests were applied by Mr. James Cocroft, under the direction of Gen. Q. A.

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[1] Read at the Minneapolis meeting of the American Association for the Advancement of Science. August, 1883.

Gillmore. The samples were crushed between steel plates, one of each stone in the direction of the schistose structure, and another in the direction across it, the former being designated as *on edge* and the latter as *on bed*, with the following results:—

Kind of stone.	Location of quarry.	Position.	Strength in pounds	
			of sample.	per square inch.
Dark trap rock, massive melaphyr.	Taylor's Falls. Chisago Co.	On bed	105,000	26,250
		On edge	105,000	26,250
Dark trap rock, from a dyke.	Tischer's creek. Near Duluth, St. Louis Co.	On bed	105,000	26,250
		On edge	105,000	26,250
Gray gabbro, massive, fine.	Rice's Point. Duluth, St. Louis Co.	On bed	109,000	27,250
		On edge	105,000	26,250
Red, fine syenite.	Beaver Bay. Lake Co.	On bed	106,000	26,500
		On edge	103,000	25,750
Red, quartzose syenite.	Watab. Benton Co.	On bed	103,000	25,750
		....	est. 103,000	est. 25,750
Red, quartzose syenite.	East St. Cloud. Sherburne Co.	On bed	112,000	28,000
		On edge	105,000	26,250
Red quartzyte.	Pipestone City. Pipestone Co.	On bed	111,000	27,750
		On edge	108,000	27,000
Massive, gray syenite, quartzose.	East St. Cloud. Sherburne Co.	On bed	105,000	26,250
		On edge	103,000	25,750
Fine-grained gray syenite.	East St. Cloud. Sherburne Co.	On bed	112,000	28,000
		On edge	105,000	26,250
Fine-grained gray syenite.	(Probably imperfect sample). Sauk Rapids.	On bed	86,000	21,500
		On edge	100,000	25,200
	Average of 20 samples.............................		104,800	26,200

In order to make a fair comparison, the resultant average strength of the Minnesota samples, crushed between steel plates, should be referred to wooden cushions. Gen. Gillmore's experiments indicate that granite has a greater crushing strength between steel plates than between cushions of wood, amounting to eleven per cent. of its strength between steel. Making such allowance, the average of the Minnesota granites becomes:—

Average strength of 20 samples of Minnesota granites, unpolished, crushed between wooden cushions. 2-inch cubes. Pounds, per 2-inch cube, 93,272; per square inch, 23,318.

This result is obtained by including the strength of the samples both *on edge* and *on bed*, in one calculation.

The following table shows the same data for 20 New England granites, reported by Gen. Gillmore, the most of them being *on bed*, or undesignated as to whether on bed or on edge. In selecting these, I have chosen the stronger of the New England granites from general Gillmore's table, and in all cases except one (in which the strength *on edge* is reported greater than *on bed*) I have chosen the strength *on bed*, when known. I have avoided every possible error that might be made in favor of the Minnesota granites, and allowed several points that count in favor of the New England granites.

TABLE

showing the compressive strength of New England granites in 2-inch cubes, as reported by Gen. Gillmore (Report of the Chief of Engineers, 1875, Part II). In unpolished cubes, on wooden cushion-blocks.

		Position.	Strength in pounds	
			of sample.	per square inch.
Blue.	Staten I., New York.	On bed	89,250	22,315
... .	Fox Island, Me.	....	59,500	14,875
....	Dix Island, Me.	....	60,000	15,000
Dark.	Quincy, Mass.	....	71,000	17,750
Light.	Quincy, Mass.	....	59,000	14,750
Flagging.	North river, N Y.	....	53,700	13,425
....	Cape Ann, Mass.	On bed	59,750	14,937
Porter's rock.	Mystic river, Conn.	On bed	72,500	18,125
Gray.	Stony creek, Conn.	On bed	60,000	15,000
Gray.	Fall River, Mass.	On bed	63,750	15,937
Bluish gray.	Keene, N. H.	On bed	41,000	10,250
Bluish gray.	Keene, N. H.	On bed	51,500	12,875
....	Millstone Pt., Conn.	....	64,750	16,187
....	Greenwich, Conn.	....	45,200	11,300
Niantic river..	New London, Conn.	....	50,000	12,500
Niantic river..	New London, Conn.	On edge	56,700	14,175
....	Vinal Haven, Me.	....	52,600	13,150
....	Vinal Haven, Me.	....	67,000	16.750
....	Westerly, R. I.	On bed	58,750	14,687
....	Westerly, R. I.	On edge	59,750	14,937
	Average of 20 granites	....	59,785	14,946

We find here that the

Average strength of 20 New England granites, unpolished, crushed between wooden cushions in 2-inch cubes, is, in pounds, per 2-inch cube, 59,785; per square inch, 14,946.

This shows that the average strength of the Minnesota granites is fifty-six per cent of the strength of the New England granites greater than that of the New England granites.

This anomalous result was so striking that I called general Gillmore's attention to it. The strength of the Minnesota 2-inch cubes was so great that it exceeded the highest registration of the gauge in use, and the samples were not reported at first, but were retained for crushing on a more powerful machine at Boston. It occurred to me that possibly there had been a gradual deterioration in the machine, or in the gauge, so that the registration was uniformly too high, and this impression was strengthened by comparing the results with the results reported in 1875, for some other stones. One of the limestones reported in 1875 was from the same place (Lemont, Ill.) as one of those I had included in my series, the same being used largely in this city. While at that time the strength of this stone did not reach beyond 14.000 pounds per square inch, the samples I had sent was not crushed because it exceeded 100,000 pounds, the limit of the gauge. Again, one of the granites sent in my series, had been reported in 1875. I refer to that from St. Cloud. The gabbro from Duluth had also been reported. Neither of these then reached beyond 19.000 pounds per square inch, but now one is reported at about 26.000 pounds, and the other about 27.000.

I called Gen. Gillmore's attention to these discrepances in order that if any error had been committed it might be detected by a retesting of his gauge, and the proper correction applied before the results were published. Subsequently Mr. Cocroft wrote me that he had the hydrostatic press taken apart and refitted, and the old gauge tested by its maker, who formed a variation of only 200 pounds in 100,000 pounds. On reporting this to general Gillmore, Mr. Cocroft was authorized to have a new gauge made, which should register 175.000 pounds. This new register was used in testing the refractory 2-inch cubes from Minnesota; hence their actual strength is as certainly ascertained as is possible with the apparatus employed.

Now, in discussing this curious anomaly, in order to reach an explanation of it, we are driven to one of three conclusions.

1. Either the cubes used were too large, or,
2. The methods are defective, or,
3. Minnesota granites are actually stronger than those of New England.

(1) Were the cubes too large? I show here several surplus cubes of the same size and style, made at the same time and by the same man, with the same instruments. These are exactly two inches on a side, measured with any ordinary standard. It is evident the great excess of strength shown by the Minnesota cubes cannot be due to their greater size, since the cubes would require to have been very noticeably and remarkable greater than two inches, and they would have been condemned.

(2). Are the methods defective? It would be sufficient, perhaps, to answer that the tests were made with the exactness and well-known integrity of the United States Engineers, under the direction of general Q. A. Gillmore whose previous experiments and publications have made him one of the best authorities in the United States, if not in the world; and that in consequence of this phenomenon he had special trials made, and new instruments prepared, yet with the final results stated above. It must be admitted that previous tests, made at the same place (Fort Wadsworth, Staten I.), on the stones at Duluth, Saint Cloud and Lemont, giving less compressive strength to those stones than now reported, throws a shadow of doubt on the correctness of the methods employed. It may be possible to explain those three cases in some way satisfactorily, by referring them to imperfections in the cubes. It is certainly not possible to allow them to establish a rule, in the face of twenty other samples which contradict them.

(3). Are the granites of Minnesota stronger than those of New England? We must either allow this, or, on account of the carefulness of the late tests of Minnesota granites, we must impugn all the results and reasoning published heretofore by general Gillmore on the granites of New England. Allowing this, we may speculate as to its possible cause.

It had occurred to me prior to this investigation, from other considerations, that perhaps the last glacial movements in Minnesota were of a later date than those described in New England. The evident freshness of the drift in Minnesota, in its *pose*, and especially of the till, compared with that of southern New England, and southeastern New York, seems to indicate the same differences as to time, of deposit. as can be inferred between the northern and the southern portions of the state of Ohio[1], or the same portions of the state of Minnesota. Of course, the continuous tracing of the same lines of morainic accumulations from east to west will finally determine the eastern analogues of our Leaf Hills and Kettle moraines, and will give a definitive answer to this hypothesis. In the mean time, and before that is accomplished, we may perhaps account for the greater strength of Minnesota crystalline rocks by supposing them less changed superficially by the process of decay, the lateness of the glaciation to which they have been subjected having left them comparatively fresh through the recent removal of a considerable thickness.

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[1] Geological survey of Ohio. Report on Delaware county.

IV.

REPORT ON THE MUSEUM FOR 1883.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1883.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
5151	Oct. '83.	Presented	Vesicular limestone ("fossil honey-comb")	2	Lauderdale Co., Ala.	Sub Carb?	Presented by C. L. Herrick.
5152	"	"	Chert from limestone, showing fossil coral, &c	1	Waterloo, Ala.	"	" " "
5153	March '83.	"	Altered garnets, (Sudamon crystals?)	2	Michigamme, Mich	Huronian.	Presented by H. R. Harvey. (From the chlorotic schists between the quartzitic hanging wall and the magnetic iron.
5154	Aug. '83.	"	Silver ore, from Black Hawk mine	4	Ballard Mt., Silver City, N. Mex		Presented by H. R. Harvey. (Lower level, 230 feet from the surface).
5155	Nov. '83.	Geol. & Nat. Hist. Survey	Cretaceous leaves, various species, oak-like	18	Cottonwood river, S New Ulm	Dak.	N. H. Winchell. (Found in a soft, rusty sandstone.)
5156	"	" "	Cretaceous leaves, various species, beech-like	2	" "	"	" " "
5157	"	" "	Salix proteæfolia, Lesq., Andromeda Parlatorii, Heer, Platanus	8	" "	"	" " "
5158	"	" "	Laurus, Sp. n.	1	" "	"	" " "
5159	"	" "	Fragment of undeterminable leaf, areolated by maceration. (Ficus?)	1	" "	"	" " "
5160	"	" "	Pinus, Sp. n.	1	" "	"	" " "
5161	"	" "	Osseous plate, marked by striæ, 2 mm. thick	1	" "	"	" " "
5162	"	" "	Coral, in magnesian limestone in the drift	2	" "	Gal ?	" " "
5163	"	" "	Ficus, Sp. n. (compare No. 3808)	1	Austin, Mower Co.	Dak.	Deposited by Charles Bromwick.
5164	Oct. '83.	By exchange	Favorites favosus, Gold	1	Le Claire, Iowa	Niag.	From A. S. Tiffany. Davenport, Iowa.

5165	"	"	"	Favorites favosus, Gold	1	Niagara Co., N. Y.	Niag.	"	"	"
5166	"	"	"	Halysites catenulata, L.	1	?	Drift Niag?	"	"	"
5167	"	"	"	Heliolites spinopora, Hall	1	Niagara Co., N. Y.	Niagara	"	"	"
5168	"	"	"	A crinoid	1	" " "	"	"	"	"
5169	"	"	"	Pentamerus occidentalis, Hall	1	Port Byron, Ill.	"	"	"	"
5170	"	"	"	Strophodonta striata, Hall	1	Le Claire, Iowa	"	"	"	"
5171	"	"	"	Dinobolus conradi. Hall	1	" "	"	"	"	"
5172	"	"	"	Trimerella ohioensis, Meek	1	" "	"	"	"	"
5173	"	"	"	Ambonychia acutirostris, Hall	2	Port Byron, Ill.	"	"	"	"
5174	"	"	"	Pleurotomaria halei, Hall	1	Le Claire, Iowa		"	"	"
5175	"	"	"	Pleurotomaria solaroides, Hall	1	" "		"	"	"
5176	"	"	"	Cyrtoceras (sp?)	1	" "		"	"	"
5177	"	"	"	Phragmoceras parvum, H. & W.	1	Port Byron, Ill.		"	"	"
5178	"	"	"	Orthis erratica, Hall	1	Madison Co., N. Y.	Hud. River (in drift).	"	"	"
5179	"	"	"	Spirifera cycloptera, Hall	2	Albany Co., N. Y.	Lr. Held.	"	"	"
5180	"	"	"	Meristella arcuata, Hall	2	" " "	"	"	"	"
5181	"	"	"	Rhynchospira formosa. Hall	1	" " "	"	"	"	"
5182	"	"	"	Pentamerus galeatus, Dalman	1	Catskill, N. Y.	"	"	"	"
5183	"	"	"	Orthis planoconvexa, Hall	1	Albany Co., N. Y.	"	"	"	"
5184	"	"	"	Platyceras gebhardi, Conrad	1	Catskill, N. Y.	"	"	"	"
5185	"	"	"	Slab, showing Meristella sulcata, Vanx., Avicula rugosa, Con., and Leperditia alta, Con.	1	Anamosa, Iowa	Waterline.	"	"	"
5186	"	"	"	Cyathophyllum (sp.?)	1	Rock Island, Ill.	Cornif.	"	"	"
5187	"	"	"	Cladopora turgida, Rominger	1	" " "	"	"	"	"
5188	"	"	"	Spirifera capax, Hall	2	Muscatine, Iowa	"	"	"	"
5189	"	"	"	Spirifera fimbriata, Conrad	1	Davenport, Iowa	"	"	"	"
5190	"	"	"	Atrypa aspera, Schl.	2	Rock Island, Ill.	"	"	"	"
5191	"	"	"	Atrypa reticularis, L.	3	" " "	"	"	"	"
5192	"	"	"	Pentamerus comis, Owen	8	" " "	"	"	"	"
5193	"	"	"	Pentamerus arata, Conrad	1	" " "	"	"	"	"
5194	"	"	"	Strophomena hemispherica, Hall	1	Davenport, Iowa	"	"	"	"
5195	"	"	"	Pleurotomaria arata, Hall	1	Rock Island, Ill.	"	"	"	"
5196	"	"	"	Ptycodus calceolus, M. & W.	3	Davenport, Iowa	"	"	"	"
5197	"	"	"	Cyathophyllum davidsonia, Hall	1	Buffalo, Iowa	Ham.	"	"	"
5198	"	"	"	Cyathopyhllum rugosum, E. & H.	1	" "	"	"	"	"
5199	"	"	"	Streptelasma rectum, Hall	2	Rock Island, Ill,	"	"	"	"
5200	"	"	"	Favosites hamiltonensis, Rominger	1	Buffalo, Iowa	"	"	"	"
5201	"	"	"	Monticulipora monticola, White	2	" "	"	"	"	"
5202	"	"	"	Batocrinus longirostris, Hall	1	Burlington, Iowa	Burlington	"	"	"
5203	"	"	"	Terebratula linklæni, Hall	2	Buffalo, Iowa	Ham.	"	"	"
5204	"	"	"	Spirifera aspera, Hall	1	Rock Island, Ill.	"	"	"	"
5205	"	"	"	Spirifera engelmanni, M. & W.	1	Rock Island Co., Ill.	"	"	"	"
5206	"	"	"	Spirifera imbrex, Hall	1	Burlington, Iowa	Burlington	"	"	"
5207	"	"	"	Spirifera incerta, Hall	1	" "	"	"	"	"
5208	"	"	"	Spirifera pennata, Owen	1	Davenport Iowa	Ham.	"	"	"
5209	"	"	"	Spirifera perextensa, M. & W.	3	Rock Island Co., Ill.	"	"	"	"

Specimens registered in the General Museum in 1883.—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
5210	Oct. 1883.	By exchange	Spirifera plena, Hall	3	Burlington, Iowa	Burlington	From A. S. Tiffany. Davenport, Iowa.
5211	"	"	Meristella doris, Hall	1	Buffalo, Iowa	Ham.	" " "
5212	"	"	Meristella haskinsi, Hall	1	?	?	" " "
5213	"	"	Meristella meta, Hall	3	Buffalo, Iowa	Ham.	" " "
5214	"	"	Athyris angelica (?), Hall	1	" "	"	" " "
5215	"	"	Athyris vittata, Hall	5	" "	"	" " "
5216	"	"	Cyrtina acutirostris, Shumard	1	Davenport, Iowa	"	" " "
5217	"	"	Atrypa hystrix, Hall	5	" "	"	" " "
5218	"	"	Atrypa reticularis, L	10	" "	"	" " "
5219	"	"	Strophodonta demissa, Conrad	2	" "	"	" " "
5220	"	"	Strophodonta nacrea, Hall	1	" "	"	" " "
5221	"	"	Strophodonta perplana, Conrad	4	Rock Island Co., Ill.	"	" " "
5222	"	"	Pteronites decussatus, Hall	1	Buffalo, Iowa	"	" " "
5223	"	"	Productus engelmanni, var. burlingtonensis, Hall	1	Burlington, Iowa	Burlington	" " "
5224	"	"	Productus pratlenianus, Norwood	1	" "	"	" " "
5225	"	"	Productella exanthematus, Hall	1	Davenport, Iowa	Cornif.	" " "
5226	"	"	Chonetes pusilla, Hall	1	Rock Island, Ill.	Ham.	" " "
5227	"	"	Chonetes setigera, Hall	1	Buffalo, Iowa	"	" " "
5228	"	"	Fossiliferous slab	1	Burlington, Iowa	"	" " "
5229	"	"	Metoptoma umbella, M. & W.	1	" "	Burlington	" " "
5230	"	"	Gomphoceras pingue, Hall	1	Buffalo, Iowa	Ham.	" " "
5231	"	"	Phacops rana, Green	1	Rock Island Co., Ill.	"	" " "
5132	"	"	Favosites placenta, Rominger	1	Livingston Co., N, Y.	"	" " "
5233	"	"	Terebratula ontario, Hall	1	Erie Co., N. Y.	"	" " "
5234	"	"	Spirifera medialis, Hall	1	Livingston Co., N. Y.	"	" " "
5235	"	"	Spirifera mucronata, Con.	2	Erie Co , N. Y.	"	" " "
5236	"	"	Spirifera sculptilis, Hall	2	Livingston Co., N. Y.	"	" " "
5237	"	"	Trematospira gibbosa, Hall	1	" " "	"	" " "
5238	"	"	Trematospira hirsuta, Hall	2	Genesee Co., N. Y.	"	" " "
5239	"	"	Nucleospira concinna, Hall	2	Livingston Co., N. Y.	"	" " "

5240	"	"	Orthis cyclas, Hall	2	" " "	"	"	"	"
5241	"	"	Atrypa hystrix, Hall	1	" " "	"	"	"	"
5242	"	"	Atrypa reticularis, L.	4	" " "	"	"	"	"
5243	"	"	Platyostoma lineatum, Con.	3	Genesee Co., N. Y.	"	"	"	"
5244	"	"	Platyostoma strophium, Hall	2	York, N. Y.	"	"	"	"
5245	"	"	Slab, showing Streptorhynchus chemungensis (a var)., Spirifera alta and S. mucronata	1	Burlington, Iowa	Chemung	"	"	"
5246	"	"	Slab, showing Avicula circulus, H., Spirifera strigosa, Meek, S. lineata, Martin, and Nucula (sp.?)	1	" "	"	"	"	"
5247	"	"	Spirifera subrotundata, Hall	1	" "	"	"	"	"
5248	"	"	Spirifera (carteri, Hall) curpidota, Sow. (1812)	1	Le Grand, Iowa	"	"	"	"
5249	"	"	Spirifera mucronata, Con.	1	" " "	"	"	"	"
5250	"	"	Spirifera ziczac, Hall	1	" " "	"	"	"	"
5151	"	"	Stenoschisma contractum, Con.	1	" " "	"	"	"	"
5252	"	"	Palæocaris obtusa, M. & W.	1	Nauvoo, Ill.	Keokuk	"	"	"
5253	"	"	Archimedes (sp.?)	1	Keokuk, Iowa	"	"	"	"
5254	"	"	Spirifera increbescens, Hall	1	" "	"	"	"	"
5255	"	"	Spirifera keokuk, Hall	2	Iowa Falls, Iowa	"	"	"	"
5256	"	"	Spirifera pseudolineata, Hall	1	Keokuk, Iowa	"	"	"	"
5257	"	"	Orthis keokuk	1	Nauvoo, Ill.	"	"	"	"
5258	"	"	Strophodonta (sp. n.?)	1	" "	"	"	"	"
5259	"	"	Productus flemingi, var. burlingtonensis, Hall	1	Keokuk, Iowa	"	"	"	"
5260	"	"	Productus tenuicostus (?), Hall	1	" "	"	"	"	"
5261	"	"	Productus wortheni, Hall	1	" "	"	"	"	"
5262	"	"	Myalina Keokuk, Worthen	1	Nauvoo, Ill.	"	"	"	"
5263	"	"	Phillipsia portlocki, M. & W.	1	" "	"	"	"	"
5264	"	"	Zaphrentis dentata, Rominger	1	Spurgeon Hill, Ind.	St. Louis	"	"	"
5265	"	"	Productus tenuicostus, Hall	1	St. Louis, Mo.	"	"	"	"
5266	"	"	Zaphrentis spinulosa, E. & H.	1	Chester, Ill.	Chester	"	"	"
5267	"	"	Lophophyllum prolificum, McChesney	2	Bloomington, Ill.	Coal Mas.	"	"	"
5268	"	"	Fenestella shumardia, Prout.	1	Topeka, Kansas	"	"	"	"
5269	"	"	Polypora (sp.?)	1	" "	"	"	"	"
5270	"	"	Synocladia biserialis, Swallow	1	" "	"	"	"	"
5271	"	"	Terebratula bovidens, Morton	2	La Salle, Ill.	"	"	"	"
5272	"	"	Spirifera camerata, Morton	2	" " "	"	"	"	"
5273	"	"	" " "	1	7 miles N. of Geneseeo, Ill.	"	"	"	"
5274	"	"	Spirifera lineata, Martin	3	Cameron, Mo.	"	"	"	"
5275	"	"	Athyris sublilita, Hall	3	Rapids City, Ill.	"	"	"	"
5276	"	"	Rhynchonella uta, Marcou	2	La Salle, Ill.	"	"	"	"
5277	"	"	Orthis carbonaria, Swallow	2	" " "	"	"	"	"
5278	"	"	Streptorhynchus occidentalis, New.	1	Cameron, Mo.	"	"	"	"
5279	"	"	Productus longispinus, Sowerby	2	Rapids City, Ill.	"	"	"	"
5280	"	"	Productus nebracensis, Owen	1	Cameron, Mo.	"	"	"	"

Specimens registered in the General Museum in 1883.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
5281	Oct. 1883.	By exchange	Productus semireticulatus, var. ivesi, New	1	Atkinson, Ill.	Coal Meas.	From A. S. Tiffany, Davenport, Iowa.
5282	"	"	Chonetes granulifera, Owen	2	La Salle, Ill.	"	" " "
5383	"	"	Chonetes mesiloba, N. & Praten	2	Bloomington, Ill.	"	" " "
5284	"	"	Nucula ventricosa, Hall	3	Springfield, Ill.	"	" " "
5285	"	"	Nucleospira ventricosa, Hall	2	Sheffield, Ill.	"	" " "
5286	"	"	Schizodus alpina, Hall	2	" "	"	" " "
5287	"	"	Platyostoma peoriaense, McChesney	1	La Salle, Ill.	"	" " "
5288	"	"	" " "	1	Menard Co., Ill.	"	" " "
5289	"	"	Pleurotomaria grayvillensis. N. & P.	3	Bloomington, Ill.	"	" " "
5290	"	"	Pleurotomaria sphærulata, Conrad	2	Atkinson, Ill.	"	" " "
5291	"	"	Pleurotomaria subsinuata, M. & W.	4	Springfield, Ill.	"	" " "
5292	"	"	Bellerophon carbonarius, Cox,	2	Atkinson, Ill.	"	" " "
5293	"	"	" marcoulanus, Geinst	1	Bloomington, Ill.	"	" " "
5294	"	"	" percarinatus, Conrad	1	Atkinson, Ill.	"	" " "
5295	"	"	" tricarinatus, Shumard	1	" "	"	" " "
5296	"	"	Polyphemopsis peracuta, M. & W.	6	Springfield, Ill.	"	" " "
5297	"	"	Rutile (?)	1	Wellstown, in Adirondack Mts		" " "
5298	"	"	Hematite	1	Pilot Knob, Mo.		" " "
5299	"	"	Apatite	1	Iron mountain, Mo.		" " "
5300	"	"	Gypsum	1	Fort Dodge, Iowa		" " "
5311	1878.	Presented	Lower jaw with four teeth	1	Rochester, Minn.	Recent	Presented by W. D. Hurlbut (found in a marsh).
5312	"	"	Equus caballus, second molar of upper jaw, right side	1	" "	"	" " "
5313	"	"	Equus caballus, second molar of upper jaw, left side	1	" "	"	" " "
5314	Dec. 1883.	"	Lignite from a well, one piece 8 in. long	Much	Litchfield, Minn.	Cret. in dr.	G. Dickson.
5315	July 1883.	"	Pottery clay	1	Near Red Jacket R. R. bridge, Mankato	Cret.	J. G. Koller.
5316	1883.	"	Kaolin (decomposed gneiss)	1	Redwood Falls	Eozoic	S. J. Race.

5317	Nov. 1883.	Geol. & Nat. Hist. Survey	Red quartzyte	2	Sec. 8, Delton, Cot. Co.	Potsdam	N. H. Winchell.	
5318	"	" "	" "	1	Sec. 9, " " "	"	"	
5319	"	" "	" "	1	" " " "	"	"	
5320	"	" "	Upper surface of the Jordan sandstone under the Cret. clay	2	L'Huillier Mound, South Bend	Cambrian	"	
5321	"	" "	Surface of the Shakopee limestone, coated with a ferruginous crust.	1	Mankato	Shak. & Cret.	"	
5322	"	" "	"Blue stone"	6	"	Shak.	"	(J. R. Beatty's quarry).
5323	"	" "	Hydraulic shale	5	"	"	"	" "
5324	"	" "	Hydraulic limestone	8	"	"	"	(Standard Cem. Company).
5326	"	" "	Hydraulic cement	Two quarts	"	"	"	" "
5327	"	" "	White clay between the Shakopee and Jordan	Much	"	Cret.	"	" "
5328	"	" "	" " "	"	South Bend	"	"	(L'Huill. Mound)
5329	"	" "	" " "	"	Mankato	"	"	(Cement Company's quarry).
5330	"	" "	Red clay	"	"	"	"	(Near Indian lake).
5331	"	" "	Red shale	"	New Ulm	Dakota	"	(Winkelmann's).
5332	"	" "	Limestone	2	"	Niobrara	"	"
5333	"	" "	Shaly limestone	1	"	"	"	"
5334	"	" "	Calcite (nail-head spar)	2	"	"	"	"
5335	"	" "	Conglomerate (ferruginous)	2	Mankato	Dakota	"	(Near Red Jacket R. R. bridge).
5336	"	" "	Oolitic chert in conglomerate	2	"	"	"	" "
5337	Oct. 1883.	" "	Magnesian limestone	1	Sec. 20. Frankford, Mower Co.	Devonian	"	(Aaron Bush's quarry).
5339	"	" "	" " underlying the "Le Roy rock"	1	¾ mile N. of Le Roy village	"	"	(In the bed of the creek).
5343	"	" "	Conglomerate (ferruginous)	3	Sec. 13, Frankford, Mower Co.	Cret	"	
5344	"	" "	Shale (whitish)	1	1½ ms. north of Grand Meadow	"	"	(Beside the road).
5346	"	" "	Silicified wood, 75 feet below the surface	1	Sec. 8, Lakeville	Drift	"	(From a well).
5347	"	" "	Copper (2 inches square, ⅛ in. thick)	1	Rosemount	"	"	

Specimens registered in the General Museum in 1883.—Concluded.

Serial Number.	OBTAINED.		NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
5348	Oct. 1883.	Geol. & Nat. Hist. Survey	Sand (from the drift)	Much	Minneapolis	Drift	N. H. Winchell. (Bank of Tuttle's creek).
5349	"	Presented	Hydraulic cement	1	Rosendale, N. Y.		
5350	Dec. 1883.	"	Manufactured peat	Much	Near Coon creek, Anoka Co.	Recent.	Presented by Dwight Mitchell.
5351	July 24, '83.	"	Gray limestone, with dendritic markings	60	20 miles N. of Gallatin, Montana		J. B. Alexander. (Canon of the Missouri R.)
5352	"	"	Mass (2 feet long) of calcite crystals	1	" " "		" " "
5353	1883.	"	Silver ore ; big San Juan mining district	3	Near Ophir, San Miguel Co., Col.		Prof. S. H. Folsom.
5354	"	"	Magnesian limestone, hammer-dressed	1	Near Winona	St. Law	Winona Freestone Company.
5355	"	"	Pipestone, in part purplish-gray	1	Pipestone City	Potsdam	C. H. Bennett.
5356	"	"	" " " "	2	" "	"	D. Sweet.
5357	"	"	" purplish gray.	1	Baraboo, Wis.	"	Prof. R D. Irving.
5359	1881.	Geol. & Nat. Hist. Survey	Magnesian limestone, pink	12	Kasota	Shakopee	N.H. Winchell. (Hand samples).

V.

CRUSTACEA.

C. L. Herrick.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

A FINAL REPORT

ON THE

CRUSTACEA OF MINNESOTA

INCLUDED IN THE ORDERS

CLADOCERA AND COPEPODA,

Together with a synopsis of the described species in North America, and keys to the known species of the more important genera.

By C. L. HERRICK, Assistant in Zoology.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1884.

PREFACE

IN presenting what may be denominated a final report of the work done in this state upon the group of crustacea best represented, and, all things considered, most important, the author must admit that the term "final" refers only to his own opportunities and the limitation of time imposed by circumstances.

While a comparatively large proportion of all the species existing within our limits have been examined during the progress of these investigations, there undoubtedly remain many additional and curious forms to reward the search of the student. A great variation in the degree of completeness with which the different genera and species have been treated will be observed, due in part to the circumstances under which they were studied, and frequently to the poverty of material. The entomostracean fauna is quite different at different seasons, and a complete knowledge of even our local fauna requires a long period of observation. Even the dead of winter is a favorable time to study some groups. The late autumn is, perhaps, the most favorable opportunity; for then, in one group, the sexual activities are just at their height, and both sexes may be studied. A number of cladocera are restricted to this season. There are a number (how large it is not yet possible to tell) of species in both groups which are to be sought by night though no phosphorescent species are yet known. Our larger, and, especially, deeper lakes have a quite different fauna from the shallow pools and rivers. In general, the flowing waters are poor in entomostraca. The cladocera or shelled entomostraca, have here received a large share of attention, and more particularly the Lynceidæ, which are the most minute of arthropods. This study has been rewarded with an unexpectedly large number of forms, and a particularly large number of species identical with those of Europe and elsewhere. Prof. Birge is the only American writer who has attempted this group, and his valuable work has made us familiar with the more striking new species. A few new species are included in our list and several varieties hardly yet known in Europe. The remarkable Monospilius is among these. This animal has but a single larval eye in the middle of its forehead, and wears its old covering over the newly-formed shell till the latter is a curious patchwork mass. The attempt has been made to incorporate a brief description of all American species with those found in Minnesota, and also to frame keys for the larger genera, so that the place of a species among its congeners may, at least approximately be found. The difficulty of framing such keys is very great; for few authors have employed the same distinctions in their descriptions, and it is necessary to select points sharply distinctive and conspicuous from the often meagre remainder after striking off scattering particulars. In some cases this difficulty has been greatly enhanced by the possibility that some of the species should be considered synonyms or varietal forms. The tendency to combine questionable forms thus produced it was necessary to offset by what may seem a too great conservatism. Faulty, however, as these keys may be, it is hoped that they will serve a good purpose in the extent which they cover. While the limits of this work preclude much more than a systematic outline, opportunity is taken here and there to admit a word on the anatomy or development. Such allusions must be considered simply accidental, for a complete treatment of these subjects would require large volumes, and the material will be long in gathering. A larger proportion of the rare males of the cladocera are here referred to than in any previous work of equal extent. The genus Cyclops, one of the bugbears to fresh-water carcinologists, is perhaps somewhat summarily treated. The excuse must be the condition of the synonomy. However, most of the combinations made were the result of careful study of large series from different localities. The sketches illustrating this paper are photo-printed from the writer's own drawings, and, without the elegance of lithographs, serve the purpose of explaining points of structure which cannot be communicated verbally. I am indebted to Prof. A. S. Forbes for very timely aid in bibliography, without which the paper could not have been completed. To Dr. Lindthal, through my friend Mr. Oestlund, I am indebted for a like service. But my obligation is deepest to Prof. Rudolph Leuckart of Leipzig, who kindly afforded access to almost a complete set of works on European entomostraca. Prof. C. W. Hall has collected at much expenditure of time and labor a set of specimens from different parts of the state which he kindly placed in my hands, thus enabling me to observe the great similarity of widely-separated faunæ. Mr. Lieberg also sent specimens of Diaptomus stagnalis from saline pools in Dakota.

INTRODUCTORY.

> "Evading e'en the microscopic eye,
> Full nature swarms with life; one wondrous mass
> Waiting the vital breath, when Parent Heaven
> Shall bid the spirit blow. The hoary fen,
> In putrid streams, emits the living cloud
> Of pestilence. Through subterranean cells,
> Where searching sunbeams scarce can find a way,
> Earth animated heaves. The flowery leaf
> Wants not its soft inhabitants. Secure
> Within its winding citadel, the stone
> Holds multitudes. * * where the pool
> Stands mantled o'er with green, invisible
> Amid the floating verdure, millions stray.
> * * Nor is the stream
> Of purest crystal, nor the lucid air,
> Though one transparent vacancy it seems,
> Void of their unseen people."—*Cowper*.

To the poet only, and the man of science, is it given to meet these "unseen people" on those familiar terms which warrants the use of the word intimacy; yet may not we who, like Sam Weller, find our "vision limited," because we have only eyes, avail ourselves of the kind introduction these people give us, and shake hands, as it were, though perhaps a little stiffly, with our neighbors, the unseen people.

Whether we like it or not—Cowper intimates we shall not—these people, in one way or another, touch us constantly, and like diminutive sprites are ever active in hatching mischief or doing their little favors to humanity. Happily most of these are amiable goblins, and are tireless in endeavors to secure us against our insidious enemies of their own ilk. With your permission we will draw the curtain which separates us from the naiades of our pools and streams.

The numbers of living forms to be found in any pool is a constant surprise even to the student of this subject, and the variety and unique character of the animals, particularly, cause a constant flow of wonder and admiration. Confining ourselves to the crustacean forms which are, perhaps, most typical, abundant and interesting of the smaller animals of fresh waters, it is to be remarked that they are of a practical value to an extent which can hardly be correlated with their seeming insignificance.

To understand this fact it is first necessary to recollect that water in some form is an indispensable vehicle for the nidus of disease germs as well as of all life; desiccation means death. The abundantly-watered portion of our country must become permeated with the pestilential hordes ingendered in its fens did not this army of devouring animalculæ destroy the decaying matters accumulating in the waters.

Their importance depends largely on their minute size and unparalleled numbers. The majority of non-carnivorous crustaceans are so constituted that their diet is nearly confined to such floating particles of matter as are present in the water, in a state of more or less fine comminution; for, nearly without prehensile organs, these animals, by means of a valvular or, at most, ladle-like labrum, dip from the current of water kept flowing by the constant motion of the branchial feet, such fragments as the snail and scavenger-fish have disdained. All is fish which enters the net. Think of it, poor dyspeptic, a constant supply of food of every variety and no question asked for stomach's sake! Bits of decaying algæ or the broken fragments of a disintegrated mosquito, all alike acceptable and unhesitatingly assimilated.

Nor is the sanitary aspect the only one in which the *entomostraca*, as our minute crustacea are collectively called, command attention; they are valuable also as a food supply.

Now, does some one jump at the conclusion that the water we drink is filled with aliment in such pleasant form as that represented above—that Dr. Tanner after all lived on a watery solution of entomostraca? Too fast, my friend—food for fishes, but not therefore an insignificant element in our cuisine economy; for it has recently been shown by Prof. Forbes of Illinois, that some of our best fresh-water food fishes are almost dependent on some one or more species of entomostraca. Darwin shows that cats regulate the clover crop of England via field-mice and humble-bees, but it is not half as far from our "bugs" to the price of trout and whitefish.

Still we are not prepared to be surprised at this, for have we not long understood that whales go fishing, with their whalebone nets, for little mollusks not big enough to excite the cupidity of the catorial small boy?

The fact is, that the principle laid down by the Deacon (of venerable memory) that "the weakest pint must stand the strain," maintains in nature aside from the nature of "shays." The minutest forms are in some sense the most important, for they are the links which stand nearest the rock, and if they be loosened the dependent series falls.

The animals of the above group are, it is likely, the best criteria by which to judge of the purity of natural waters if their distribution were correctly understood. The presence of some species in great numbers is sufficient evidence of organic impurity. A critical study of the contents of samples of such waters will enable us to determine their character almost as well as by analysis. The following list of the animal life visible in a quart of filthy pond-water, taken by simple dipping, will perhaps be suggestive on this point:

Daphnia pulex	6
Ceriodaphnia	1400
Simocephalus	56
Cypris	50
Cyclops	30
Sand-fleas	120
Total Crustacea	1662
Infusoria	35
Arachnida (*Hydrachna*)	1
Vermes	5
Insecta—	
Coleoptera (larvæ)	8
Diptera (larvæ)	11
Hemiptera	10
Mollusca	35
Total	1767

The above are simply the animal forms visible to the (trained) unassisted eye; the truly microscopic forms number vastly more.

But each gathering includes specimens of carnivorous entomostraca as well, and these are not less interesting and bizarre than the cladocera.

The common cyclops, busy picking the bones of a luckless polliwog (must we say purwiggy?), is not less benevolent than the animate filters mentioned above. The amount of such material that they will dispose of in a short period of time is truly astonishing. It is the province of the following chapters to describe briefly such of these animals as fall in the two groups Cladocera and Copepoda and have been noticed in America.

CHAPTER I.

THE ENEMIES OF ENTOMOSTRACA.

First among these rank the young of various fishes which prey upon, and find their entire support in, these minute animals. This subject has been fully treated by Forbes, Ryder and others.

The enemy next most dreaded by entomostraca is, perhaps, the "spectre animalcule" or the larva of the little frost-gnat, corethra. It is no unusual thing to see a corethra carefully gorging itself with a fat cyclops, suddenly seized by the protractile jaws of the dragon-fly larva, shaken for a minute and then engulfed in the tomb-like cavernous mouth below. Nor is the road to the stomach of the dragon-fly always so circuitous. Water-tigers also, with other larvæ, prey upon these unfortunates. The hydra considers them a dainty morsel, and at once paralyzes them by the touch of his nematocystiferous arms; in other words, by the poisonous barbs coiled in concealment in the cells of the tentacles.

If the animal flys from these ubiquitous enemies he almost certainly is betrayed by carnivorous plants which abound in all our waters. Forbes says: "In ten bladders of *Utricularis vulgaris*, taken at random, I found 93 animals, either entire or in recognizable fragments, and representing at least 28 species. Seventy-six of the animals found were entomostraca, and belonged to 20 species." "Just one-third of all the animals found in these bladders belonged to the single species *Acroperus leucocephalus*, Koch."

But among the ranks of enemies must be included certain parasites, both external and internal, of which a variety are known. A few of the most remarkable of these will be mentioned. I may be permitted to quote from an article in the American Naturalist, April, 1883:

"We have discussed the relation of the minute fresh-water crustacea to sanitary science in a paragraph in a recent article in the Naturalist, but it remains to touch upon another phase of the subject. It may be thought unnecessary to trouble ourselves about the pathological conditions prevailing among such lowly animals, but it can be shown that these same causes of disease may not be unimportant in connection with human diseases.

It is a fact constantly receiving new exemplification, that the parasites infesting small animals, particularly water animals, are frequently but the immature forms of parasites of animals higher in the scale. These alternating generations are exceedingly difficult to study, so that while all stages may be separately known, only a fortunate combination of circumstances or patient accumulation of facts can connect the individual factors into the complete cyclus.

Thus, for example, Prof. Leuckart has but recently worked out the full life-history of *Distomum hepaticum*, although the adult has been a stock example in helminthological study in the laboratory for years.

The importance of such parasites, even in a commercial view, needs but a reference to trichinosis to illustrate. I am not aware that endo-parasites are known in entomostraca except in the case of cyclops. Embryos of *Cucullanus elegans*, a nematoid worm, enter the body cavity of cyclops and undergo two moults and then are transferred to the intestinal canal of food fishes.[1]

A similar parasite of cyclops is *Filaria medinensis*.[2]

The cladocera are generally quite free from parasites, but I have found in several instances young nematoids in the blood sinus in front of the heart in *Daphnia schæfferi*. These worms subsist upon the nutriment in the blood which constantly bathes the animal. True cysts could not be formed in the cobweb-like tissues of the hosts. This is, so far as I can learn, the first publication of entozoa from cladocera, and the parasites are figured in Plate T, Fig. 15. The animals were from 'Schimels Teich,' Leipzig.

While collecting copepods near Tuscaloosa, Ala., I gathered a number of specimens of *Cyclops tenuicornis*, and nearly all were unusually pale and feeble. On examination they proved to be infested with a worm of the sub-order Distomeæ. This sub-order includes many distressing parasites and forms which are adapted to be widely distributed by a long period of adolescence, and the number of stages passed through before maturity is attained."

"The larvæ live frequently in mollusca, and in maturity inhabit the intestine of vertebrates.

Upon examination, the cyclops individuals collected were nearly all found affected, some having as many as five parasites of various sizes about the alimentary canal, in the common vascular cavity which corresponds to the entire arterial and venous system of the more highly organized Calanidæ. The Cercerian or tailed stage was not found. Were the life-history known it would probably appear that the larval stage is passed within some young mollusks, and that the adult infests some vertebrate, probably fish, and would thus be perhaps transferred either in food or drink to the human system.

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[1] Claus. Kleines Lehrbuch d. Zoologie, p. 368.
[2] Fedschenko. Ueber d. Bau. u. d. Entwicklung d. *Filaria medinensis*, Moscow.

It is worthy of notice that the host was soon destroyed by the parasite, the post-imago or coronatus form being absent; most of the individuals thus infested possessed abnormally persistent larval characters in antennæ, etc." (See also below on Lagenella mobilis).

The external parasites are more numerous but, in the main, less dangerous. Among these are a variety of algæ, and colonies of Vorticellæ and related animals. There is almost always a colony of Acineta near the anus of Cyclops phaleratus. Rarely Stentor is found upon the body of Cyclops.

The most remarkable ectoparasite among the protozoa is the remarkable louse-like ciliate protozoan, to be described beyond, found as a parasite of Diaptomus pallidus.

Finally, certain of the rotifera are very constant enemies of the entomostraca, one species making its diet almost exclusively of Chydorus sphæricus and stowing them away with remarkable facility with its forceps-like jaws.

A NEW SPECIES OF CORETHRA.

(Plate V. Figs. 1-4)

The Corethra plumicornis as known in the larval form is one of the most abundant of the inhabitants of our inland waters, and its form and habits are sufficiently well known. (See *Types of Animal Life* by the author for description and figures.)

A second, and presumably new, species was found in a night gathering from Lake of the Isles near Minneapolis. In motion it differed so entirely, though indescribably, that the eye recognized it at once as new. The few specimens then obtained were all that have been seen, but I will here give a brief description of the larva and pupa in hope that the imago may finally be encountered.

The form is more slender than in C. plumicornis. The tracheal vessels are of a different form and color, and the viscera have obvious differences. Most conspicuous variations, however, are seen in the shape of the head, which is slender and attenuated toward the insertion of the antennæ. The antennæ are shortish and have a spine outwardly. The cuticular appendages have an unusual form as has the labrum. The anterior part of the head is spiny. The armature of the end of the abdomen is peculiar.

The posterior rudimentary appendages are of a different form, and the claws are replaced by club-shaped bodies. A curious appendage below is indicated in the name. The pupa has an extraordinarily elongate abdomen which terminates in two paddle-like appendages loosely ciliated outwardly. This species may be called

Corethra appendiculata, sp. n.

A NEW ECTOPARASITIC PROTOZOAN.

(Plate V. Figs. 12–13.)

The very strange monocellular animal referred to was found scurrying over the body of Diaptomus pallidus in a manner like that of a louse scrambling over a bare spot upon its host. The body is disc-shaped and about .04 mm. in diameter. The lower or ciliated side is flat and circular. The upper or aboral portion is convex with an annular depression of greater or less regularity about half way from the center to the margin. The lower side has a chitinous barred ring, corresponding to the depression above, containing about 25 radially arranged bars, each of which, apparently, forms the support for a long cilium which with the others forms a circlet extending beyond the margin. These cilia are used as feet and by them the animal is able to move in any direction, apparently with none of the uncertainty of motion usual to ciliate infusoria. The protoplasm is granular and contains one or more contractile vesicles, one of which appeared very regularly in the center of the chitinous ring before mentioned. These animals can also swim freely, but after a short excursion usually came quickly back, and after shuffling or sliding over the smooth surface of the crustacean assumed a position of repose. The generic affinites of this protozoan are uncertain (Chilodontidæ?); the specific name may, perhaps, be safely applied as follows:

pedicularis, sp. n.

Cragin notices the occurrence in American species of Cyclops of *Lagenella mobilis*, Rehberg. This gregarine (?) was found by him at Cambridge, inhabiting in large numbers the digestive tract of species of Cyclops, and has since then been observed in Minnesota.

CHAPTER II.

ORDER CLADOCERA.

This very extensive group contains a variety of types, but there are sufficiently evident connecting links uniting the extremes of structure. The Gymnomera which, following the usual custom, we include here, stand distinct from the other groups, yet have sufficiently evident cladoceran affinities. It is very unfortunate for ætiological speculation that this the only truly marine group should stand thus isolated from its fellows. According to the notions at present prevailing, the Phyllopods stand nearest the primitive type of crustacea. There are unmistakable hints at an early origin for that group, and not less evident are certain analogies with both Cladocera and Copepoda.

There has, however, recently been made an attempt to derive the Phyllopods from an original cladoceran stem with, as we think, somewhat unsatisfactory results. Do we not the rather see in both groups two like phases which may be looked upon as incidental and comparatively trivial. The shelled and the shell-less phasis appears in both. The most closely shelled Phyllopod is unmistakably nearer Branchipus even than any of the Cladocera. It would seem that the brief and imperfect embryonic nauplius condition of the latter sufficiently indicated their later origin. Again no fanciful analogy can unite the Ostracoda with the Lynceidæ. We know of no recent discoveries casting discredit on the remark of Balfour: "the independent origin of the Ostracoda from the main crustacean stem seems probable."

Prof. Packard says:[1]

"We imagine that when a permanent body of fresh water became established, as, for example, in perhaps early Silurian times, the marine forms carried into it in the egg-condition, possibly by birds

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[1] "A Monograph of the Phyllopod Crustacea," etc., *XIIth Annual Rep. U. S. Geol. and Geog. Surv. Terr.*

[sic?] or by high winds, hatched young, which under favorable conditions, changed into Sida, Moina, and Daphnia-like forms. The Cladocera are, then, probably the more generalized forms, from which the Phyllopods, at this time and probably ever since Devonian times, *par excellence* a fresh-water assemblage of forms, took their origin." Whatever affinity there may be between the shelled Phyllopods and the Cladocera, it would seem that the evidence is conclusive that the latter group is not the direct continuation of the line of development inaugurated by an ostracode ancestor. As shown beyond, the present centre of the group seems near Moina with indications of a divergence from this rather generalized type, especially of degradation and heteronomy on the side of the Lynceids.

It seems at the present time that more might be accomplished for ætiology by a careful study of such groups as the present, in which are a variety of closely allied forms than by the attempt to join widely separated groups. When we shall have siezed upon the latest eddies and mapped their direction, it may become possible to combine the indications in such a way that lines of divergence thus traced accurately through some small part of their course may be produced backward to their intersection. This then is our present duty—the accurate mapping of minute districts and the careful noting of any moving straws, competent to indicate movements in the vast complex of vitalized nature. We conceive the cladocera to have had a comparatively recent origin, and to express the culmination and retrograde development of a plan of structure first differentiated after the appearance of clear bodies of fresh water. All the species save a very few are confined to inland waters. Accepting the above mentioned theory, the Sididæ will occupy the first place as departing least from the type from which the whole group sprang, while it is connected by the genus Daphnella with the Daphnidæ. The Daphnidæ, beginning with Moina, find their ultimate development in some monstrous forms of the genus Daphnia, but pass into the Lyncodaphnidæ by way of Macrothrix. The links uniting all these minor groups are very obvious.

Our own ideas of the relationships among the Calytomerous Cladocera are expressed in the accompanying table. This table is to be considered a projection of a portion of a genealogical tree, seen from below, in which the genus Moina forms the arbitrarily chosen fixed point. The heavy dotted line is imagined as directed downward vertically. That branch rising toward the top of the page is growing obliquely upward. The Daphnidæ are represented as expanding upon the same plane as Moina, and the Lyncodaphnidæ extend diagonally downward, producing the Lynceid branch The Bosminidæ spring from the stem at a lower point. These relations are made obvious by the figure giving a view of the ideal tree as seen from the side.*

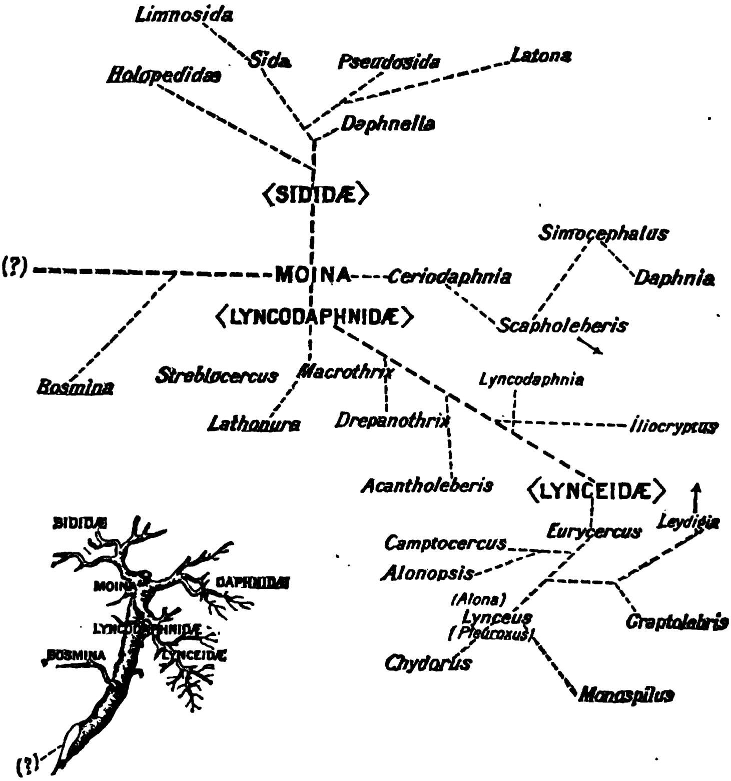

FIG. 1.—TABLE ILLUSTRATING THE RELATIONS OF THE

CLADOCERA CALYPTOMERA.

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*NOTE.—To adapt the diagram to the theory that the Lynceidæ are the progenitors of Cladocera, it is only necessary to revolve the imaginary line to the right, till it coincides with the axis of that family. The question mark may be understood to indicate that the source of the pivotal group, Moina, is uncertain. The author must confess that his inclination is toward a belief that the line culminating in the Daphnidæ diverged from a group of organisms resembling Phyllopoda, more definitely, resembling Limnetes. There is a very remarkable resemblance between the larva of Limnetes and Bosmina. The lateral spines of the former are, as will be shown true homologues of the antennules of Bosmina. The later origin of the Phyllopoda in their present form may be well admitted.

[1] Entomostraca, seu Insecta testacea, quæ in aquis Daniæ et Norwegiæ reperit descripsit, etc. *Otho Friedric Mueller*, 1785.

[2] Monoc. qui se trouvent aux Envir. de Geneve.

The Cladocera or Daphnoidea are characterized by the more or less leaf-like feet, and the lamina of thin chitine which encloses the greater part of the body, or at least forms a sac for the protection of the eggs. This so-called shell springs as a fold from the maxillary segment and is tho most conspicuous and variously formed, while really least important, of the structural peculiarities.

All Cladocera begin life with a single median eye, but some lose it during later life. In one case it remains the only visual organ.

The outer covering is in most cases changed by frequent moults. The period of the moult is one of the most precarious in the life history of the animal.

Although figures and brief descriptions of animals belonging to this group are to be found in the works of Swammerdam, Leewenhoek, Trembley and other of the older authors, Mueller[1] was the first to produce a systematic work upon these in common with other minute fresh-water crustacea. He may be called the father of the study of micro-crustacea. Jurine,[2] an eminent Swiss naturalist, was the next to contribute important discoveries relating to these interesting animals, though Ramdohr had given anatomical details of several species. Gruisthuisen, a little later gives farther details of Daphnia sima (Simocephalus). The work of Milne Edwards gives a resume of what was known regarding these animals in that period. Soon afterwards the work of Baird became the beginning of a new era, and the study of the minute crustacea sprang into importance at once. The Scandinavian peninsula being the birth-place of the science, it is proper that the most exhaustive work on the group should be performed there.

The most important of the later writers are Leydig, Schœdler, Fischer, Lilljeborg, P. E. Mueller, Sars, Weismann, Claus and Kurz.

The complete bibliography of the subject up to Mueller's time is found in Baird's *British Entomostraca*; the greater part of the later bibliography is to be found in P. E. Mueller's Danmark's Cladocera. A few only of the more important works are here mentioned.

Koch, C. L., Deutchlands Crustaceen, etc.
Schoedler, J. E., Ueber Acanthocercus rigidus, etc.
Dana, J. D., Crustacea of the Wilkes' Exploring Expedition.
Lievin, Die Branchiopoden der Danziger-Gegend.
Fischer, Leb., Ueber die in der Umgegend von St. Petersburg vorkommenden Crustaceen, etc., 1851.
Lilljeborg, W., De Crustaceis ex ordinibus tribus, (or) Om de inom Skane forekommande Crustaceer af ordningarne Cladocera, Ostracoda och Copepoda.

This valuable work is particularly good on the Cladocera, but is unfortunately without Latin descriptions; so that the Swedish text is a hindrance to its usefulness. It is chiefly of historic value now. Large 8vo; Lund, 1855.

Schoedler, J. E., Die Branchipoden der Umgegend von Berlin, 1858.
Smitt, F. A., Sur les Ephippes des Daphnes.
Lubbock, J., An account of the two methods of reproduction in Daphnia, etc.
Leydig, Fr., Naturgeschichte der Daphniden.

The most magnificent work published.

Lilljeborg, W., Leptodora hyalina, 1861.
Sars, G. O., Om Crustacea Cladocera, iagttagne i Omegnen af Christiania, 1862.

This valuable work is difficult of access, printed on thin paper and without illustrations. A second paper by the same author in 1863 is mentioned, but I have never seen it.

Schoedler, J. E., Neue Beitrage zur Naturgeschicte der Cladoceren, 1863.

One of the most important works on the Lynceidæ. The author is rather too credulous and inclined to form new species.

Klunzinger, Einiges zur Anatomie der Daphniden nebst kurzen Bemerkungen ueber die Susswasserfauna der Umgegend Cairo's.
Sars, G. O., Norges Ferskvandskrebsdyr Cladocera ctenopoda, 1865.

The best work on the Sididæ, etc.

Mueller, P. E., Danmark's Cladocera.

One of the most useful books on the subject. Especially good on Lynceidæ and Bosminidæ.

Plateau, Felix, Recherches sur les Crustaces d'eau douce, etc., 1867-69.
Mueller, P. E., Note sur les Cladoceres des Grands Lacs de la Suisse.
Weismann, A., Bau und Lebenserscheinungen Leptodora hyalina.
Sars, G. O., Om en dimorph Udvikling Samt Generationsvexel hos Leptodora, 1873.
Claus, C., Zur kennt. d Organ. u. d. feineren Baues der Daphniden.
Claus, C., Zur kennt. des Baues, etc., der Polyphemiden.
Gruber and Weismann, Ueber einige neue oder unvollkomen gekannte Daphniden.
Weismann, Thierleben im Bodensee, 1877.
Lutz, A., Untersuchungen ueber Cladoceren der umgebung von Bern.
Claus, C., Die Schalendruse der Daphniden, 1874.
Spangenberg, Fr., Ueber Bau und Entwicklung der Daphniden.
Lilljeborg, W., Crust. Suececorum Ordin. Branchiop. et Subord. Phyllop., 1877.
Pavesi, P., Nuova Serei di recherche della fauna pelagica nei laghi Italiani, 1877-1879.
Grobben, C., Zur Entwicklungsgeschicte d. Moina rectirostris, 1789.
Weismann, Beitrage zur Naturgsch. der Daphnoiden, Leipzig, 1876-79. (Valuable on the physiology).

The American literature may be catalogued in a few lines. The first descriptions and figures with which I am familiar are those in the Rep. of the U. S. Fish Commission, 1874, where S. I. Smith notes Daphnia galeata, D. pellucida and D. pulex; also a species of Bosmina, Eurycercus lamellatus and Leptodora hyalina.

A. E. Birge was the first to systematically study Cladocera in America, and his "Notes on Cladocera" furnished a basis upon which to build. A few notes were published by the writer a little later.

A few additional notes and descriptions of new species were published in the *eleventh annual report of the Minnesota geol. and nat. hist. survey.*

Prof. Birge published other notes in the *Medical Journal and Examiner* of Chicago, which I have not seen.

Prof. Forbes of Normal, Ill., in an article in the *American Naturalist*, July, 1882, adds a number of facts and one new species.

In addition to the above, a figure of Sida was printed in one of Hayden's Survey Reports, and some account of the Cladocera of lake Michigan was given by B. W. Thomas, I believe, in one of the official reports of the Chicago Water Commission.

CLASSIFICATION OF THE CLADOCERA.

SUB-ORDER I.—CALYPTOMERA (membrane-clothed).

Body enclosed in a bivalve shell. Mandibles truncate below. Maxillæ distinct, spiny. Thoracic ganglia discrete.

TRIBE I.—CTENOPODA.

Feet six, similar, foliaceous, all distinctly branchiate.

FAM. 1.—SIDIDÆ.

Swimming antennæ with two unequal rami, intestine simple.

FAM. 2.—HOLOPEDIDÆ.

Swimming antennæ simple, elongate cylindrical (in the male prehensile), intestine with two lateral dilations.

TRIBE II.—ANOMOPODA.

Feet five (or six) pairs, the anterior pair more or less prehensile and destitute of branchiæ.

FAM. 1.—DAPHNIDÆ.

Rami of antennæ three and four-jointed, five pairs of feet, the last with a curved appendage guarding branchial sac; antennules of female short, one-jointed.

FAM. 2.—BOSMINIDÆ.

Six pairs of feet, antennules elongated, many-jointed.

FAM. 3.—LYNCODAPHNIDÆ.

Antennules of female elongated, but one-jointed; intestine simple or convolute.

FAM. 4.—LYNCEIDÆ.

Antennæ with both rami three-jointed, intestine convolute, with abdominal but no anterior cæca.

SUB-ORDER II.—GYMNOMERA (destitute of covering).

Body without or nearly destitute of bivalve shell; feet not branchiate, spiny. Anterior thoracic ganglia in one mass.

FAM. 1.—POLYPHEMIDÆ.

Abdomen curved, terminating in two long stylets.

FAM. 2.—LEPTODORIDÆ.

Abdomen straight, ending in short claws.

FAMILY SIDIDÆ.

Head separated from the body by a depression, without prominent fornices (or spreading shields) over the base of the antennæ. First pair of antennæ, or antennules, as we shall uniformly call them, one-jointed, usually rather small in the female, but extending into a very strong flagellum in the male. Antennæ long, biramose, with unequal branches. Mandibles truncate at the end. Maxillæ armed with large spines. The form is usually elongate, and the abdomen often extends beyond the edge of the shell behind. The male openings are usually in the end of long appendages which depend from the base of the post-abdomen. This interesting family is represented in America so far by four species, one of which constitutes a new genus. Others will undoubtedly be found upon a careful study of the fauna of the great lakes Most of the species prefer the clearer and colder water of large lakes. The processes of development, as traced by the writer, vary very little from the method exhibited by Moina. The ephippial condition, however, is not found in these animals which are less subject to destructive influences of the climate. They do, however, produce so-called winter eggs which are laid in October and are distinguished from the summer eggs, which hatch in the brood cavity, by a brown color and the presence of fatty spheres. These eggs are produced in large numbers in distinction from most other Cladocera in which the winter eggs are very few. These eggs are permitted to settle to the bottom and there develop at the proper time. Sida crystallina is often found in immense numbers in large lakes which contain abundant plant growth. The size, and especially the reproduction activity, is very dependent on the environment, and hence little success is obtained in preservation in aquaria. Some of the genera are nocturnal and should be sought at the surface on quiet evenings.

I.—GENUS SIDA. Straus.

(Plate N. Figs. 12-14.)

Body elongate, hyaline. Head small, quadrate. Fornices absent. Antennules of female small, truncate; of male, with a long flagellum. Second antennæ with the rami two and three-jointed. Male with the sexual openings just behind the last pair of feet. It is the upper or longer branch of the antennæ which in Sida is three-jointed, while the reverse is the case in the next genus. The only species, according to P. E. Mueller, is the ubiquitous S. crystallina. The S. elongata of Sars is distinguished by the smaller head and its concave lower margin and more elongate shell. The terminal joint of the longer ramus has one less seta than S. crystallina, while the post-abdomen has more numerous spines. We incline to believe it a valid variety at least. The bibliography below is extracted from a previous report:

Daphne crystallina,	Mueller.
Daphnia crystallina,	Latreille, Bosc.
Sida crystallina,	Straus, Mem. Mus. Hist. Nat.
Sida crystallina,	M. Edwards, Hist. Nat. Crust.
Monoculus crystallinus,	Gmelin, Manuel. Fabricius.
Monoculus elongatus,	De Geer, Mem. servir. Hist. Ins.
Sida crystallina,	Lievin, Branch. d. Danziger Geg.
	Baird, Brit. Entom.
	Lilljeborg, De crust. ex ord. trib.
	Fischer.
	Schoedler, Die Branch. d. Umg. v. Berlin.
	Neue. Beitr.
	Leydig, Naturg. d. Daph.
	Sars, Norges Ferskv—Krebsdyr.
Sida elongata,	Sars, " " "
Sida crystallina,	P. E. Mueller, Danmark's Cladocera.
	Kurz, Dodekas Neuer Cladoceren.
	Birge, Notes on Cladocera.
	Herrick, Microsc. Entom.
	Lutz, Untersuch, u. d. Cladoceren d. Umg. v. Bern., 1878.
	Weismann.
	Grobben, Entwicklung. Moina.
	Herrick, Crustacea of Minnesota.

II.—Genus Pseudo-sida. Herrick. (Genus n.)

Similar to Sida. Antennules of the female, with a long flagellum, like that of the male of Sida, sensory setæ lateral. Body elongate, head short, extending into a sharp beak. The post-abdomen is armed with groups of sharp spines or bristles. Most characteristic, however, is the fact that the antennary joint, which in Sida is two-jointed, in this species is tri-articulate, and the two-jointed ramus has a great number of setæ (16-17).

Sp. 1. **Pseudo-sida bidentata,** Herrick. (Sp. n.)

(Plate K. Fig. 9.)

Post-abdomen armed with 12–14 clusters of spinules in a transverse row; the terminal claw armed with two long basal spines, and with numbers of fine teeth on the inside. The two-jointed ramus of the antennæ has six setæ on the basal, and ten or eleven on the terminal joint, while the three-jointed ramus has a short terminal joint bearing three spines. The valves are marked with sparse spines on the lower margin. In most respects this species is like Sida, which it resembles in size. In the form of the female antennæ it is like Latona which it also somewhat resembles in the number of joints of the antennæ and the numerous setæ they bear. It is certainly an interesting transition form. Found only in swamps bordering Mobile bay, Ala., but whether in brackish or fresh water my notes do not inform me. Sida crystallina lives far out in the bay, and Daphnella is found in pools along shore.

III.—GENUS LIMNOSIDA. Sars.

(Plate N. Fig. 9.)

Head crested; eye in a conical prominence. Shell elongated, produced above in an acute angle. Antennules small, truncate in the female; in the male of enormous size; antennæ very long. Post-abdomen smooth; terminal claw spiny.

The one species, L. frontosa, Sars, is not yet known in America.

IV.—GENUS DAPHNELLA. Baird.

Neither beak nor fornices present. Antennules of female small, truncate; those of male long, flagellate. Antennæ with two-and three-jointed rami. Male with a hook on the first foot, and large copulatory organs attached to the base of the post-abdomen.

Sp. 1. **Daphnélla brachyura,** Lievin.

Sida brachyura, LIEVIN, Branch. d Danziger Geg.
Daphnella wingii, BAIRD, Brit. Entom.
Sida brachyura, LILLJEBORG, De crust. ex ord. trib.
Diaphanosoma brandtianum. FISCHER. Ergänzig. Berichtig.
Daphnella brandtiana, SARS, Norges Ferskv.—Krebsdyr.
Daphnella brachyura, P. E. MUELLER, Danmark's Cladocera.
Daphnella brachyura, LUTZ, Untersuchung u. die Cladoceren d. Umg. v. Bern.
Sida brachyura, PAVESTI, Nuova serie di recerche della fauna pelagica nei laghi Italiani (L. Trasimene).
Daphnella brachyura, HERRICK, Notes on Crustacea of Minnesota.
(Compare also *D, expinosa*, BIRGE, Notes on Cladocera p. 3.)

The species of Daphnella found about Minneapolis, occasionally abundant, seems not to differ in any important character from European types of D. brachyura, although I formerly regarded it as distinct (D. winchelli, Microscopic Entom., Addenda).

Head less than ½ the body (about .27 mm., while the body is .6 mm. long); eye about ¼ head; antennæ when reflexed extend a little beyond ⅔ the length of body. Male, .7 mm. long; antennæ reflexed, reaching base of shell; anterior antennæ extremely long; copulating organs reaching nearly to end of claws. Having carefully compared our specimens with the descriptions and figures given by Birge for his D. expinosa, the evidence seems to indicate not only that they are identical, but both are really D. brachyura. The distinctive characters of D. expinosa are a greater indentation between head and body, absence of caudal teeth, greater length of male appendages, and the opening of the vasa deferentia below the "instep" of these appendages.

The absence of teeth upon the post-abdomen is of even generic importance according to Sars, who gives it in his synopsis of genera as typical for Daphnella. In our specimens the claws are at least pectinate if not serrate, while the appendages of the male reach generally nearly to the middle of the claws. The relative length of these appendages and the antennæ of the male is variable.

Sp. 2. **Daphnella brandtiana,** Fischer.

Head as long as half the body, antennæ when reflexed reaching beyond the posterior margin of the valves. Length 0.8 mm. Of the validity of this species we can form no conclusion. It is usually considered a variety or phase of the above.

V.—GENUS LATONA, Straus.

(Plate N. Fig. 8.)

Body elongate, broad; head large and square, appendaged below with triangular laminæ; fornices present. Antennules rather large. The larger ramus of the antennæ is two-jointed and has an expanded process at the base. The lower posterior angle of the shell has a peculiar diverging set of setæ. The shell is often ornamented with numerous flecks of bright color. There is a copulatory apparatus in the male.

Latona setifera, Mueller,

Is the only species, and is not yet recognized in Minnesota, but was found by Prof. Birge in lake Michigan.

FAMILY HOLOPEDIDÆ.

GENUS HOLOPEDIUM, Zaddach.

(Plate N. Fig. 11.)

The peculiar animal bearing the name Holopedium gibberum has the brood cavity greatly elevated, and the whole upper part of the animal is covered by a jelly-like mass secreted as a protection or float. The antennæ are simple in the female and extend through a slit in this covering. In the male they are prehensile and have rudimentary inner rami. It would be difficult to recognize the affinity of the female with its monstrous form were it not for the male and particularly the development history. Found in this state probably only in lake Superior. Forbes mentions it from lake Michigan.

FAMILY DAPHNIDÆ.

The family Daphnidæ contains the genera Moina, Ceriodaphnia, Scapholeberis, Simocephalus and Daphnia, which include the commonest, as well as some of the largest, Cladocera. The genera may be distinguished by the following table:

I. **Head rounded, not beaked; antennules long in both sexes, shell not covering the end of the abdomen**........................*Moina.*
II. **Head rounded; antennules rather short; shell enclosing whole body**..*Ceriodaphnia.*
III. **Head somewhat beaked below, shell angled below or extending in long spines from the lower angle, pigment fleck roundish**...*Scapholeberis.*
IV. **Head beaked below; shell rounded below, with a blunt spine above: pigment fleck elongate**..................................*Simocephalus.*
V. **Head beaked below; shell extending in a sharp spine at the upper posterior angle; pigment fleck small**..........................*Daphnia.*

THE CIRCULATORY SYSTEM OF THE DAPHNIDÆ.

In the *Daphnidæ*, and, indeed, the Cladocera in general, we meet an instance of great development of surfaces at the expense of solidity of form and compactness of organs. The whole body is composed of an aggregate of laminæ, and the appendages all approximate more or less toward this fundamental modification. Thus, for example, the head is a leaf-like body with a laminate shield above and a pair of flat organs beneath. The abdomen terminates in a knife-like post-abdomen, while the thorax, with its narrow form, foliaceous feet and, far more, the enormous development of the outer wall to enclose, more or less fully, the entire body, is the typical illustration of this fact. Necessarily this structural modification exerts a formative influence on the internal organs which are all more or less influenced by it; and this is peculiarly the case with the more external and, in general, the paired organs. Thus the "shell glands," so called, which in Copepoda are generally coiled tubes, become here greatly flattened organs closely united with the shell. The physiological result of this modification is the sensitiveness to changes in the environment, which is universal among the *Daphnidæ.* The compact Copepoda survive the vicissitudes of confinement with comparative immuity, but the first taint in the water destroys the delicate organism of *Daphnia.* The cause for this may be found in the exposure of the most vital and delicate parts of the organism to the influences of the surrounding aqueous medium. In particular the circulatory and respiratory systems, which here are not easily to be distinguished one from the other, constitute a relatively very large area of close contact with the water. It thus happens that the central organs are influenced in a very short time by whatever deleterious substances may be disseminated in the water.

Notwithstanding this lack of centralization, the structure of these animals is of a very considerable degree of complexity and, presenting so many instructive modifications under circumstances so favorable for study, has been very thoroughly investigated. The very transparency which has made it possible to clear up many questionable points in crustaceology from the lessons learned in *Daphnia,* has rendered the investigation of certain sets of organs extremely difficult, and among these may be mentioned the circulatory system. The circulation of the nutritive fluid and the general facts connected with the heart were, indeed early understood; but there remains many a detail and some important relations which are as yet either imperfectly known or entirely misunderstood. The following notes are offered as a contribution to the, as yet incomplete, knowledge of the circulatory apparatus.

The observations were confined for the most part to *Daphnia schæfferi* and *Simocephalus vetulus*, with occasional comparisons with *Eurycercus*, *Pleuroxis, Pasithea* and others. It is greatly to be desired that the study might be carried to the Sididæ, in which the larger size and superior transparency would doubtless reward the search with several, as yet doubtful details. The circulation of the nutritive fluid in the Daphnidæ, then, is somewhat complicated, but may be divided into a superficial and a deep system. It must be remarked that this distinction is arbitrary and only used for its convenience. The one extends over the entire inner surface of the carapace, while the latter is in close relation with the vegetative organs, and extends into the branchial vessels of the feet. The nutritive fluid which is normally colorless and supplied with corpuscles of organized nutriment, (it seems doubtful if they should be called blood corpuscles) is confined for the most, if not its entire, course within membranous walls of connective tissue which, however, instead of assuming a definite form as "blood vessels," for the most part conform to the contour furnished by the firmer organs.

This membrane which is frequently folded upon itself and invests the body walls and the inner organs, is in some places free, and may be seen as a pulsating, swinging film, or, more frequently, it can only be detected as a swaying line (seen in optical sections), thus giving rise to the misapprehension that one is dealing with a thread, or as moving grains, in which case the film is itself invisible but its presence is indicated by the attached grains of protoplasm. About the heart the free swaying portions of this membranous layer are so numerous as to render it almost impossible to distinguish the essential from the accidental appearances.

This membrane must serve the most various purposes; aside from the mere retention and direction of the blood currents, it is often transformed into a branchial surface. At definite points it becomes the bearer of the cells which were above mentioned as grains of protoplasm. These are most numerous in young and well-fed animals, and in particular in gravid females, while, on the contrary, mature males and females after the escape of the young, are nearly devoid of such bodies. These are most numerous in angles of the membrane, particularly about the heart, shell glands, ovaries, intestine and the branchial spaces in the feet.

These cells vary in size from that of the blood corpuscles to larger cells with nuclei of comparatively very large size. It would be too much to say that such cells are developing blood corpuscles; but that they are reservoirs of nutriment which serve to supply the increased demand upon the blood in exigencies of the existence of the animal, cannot be doubted. It is a well known fact that the number of blood corpuscles, so called, likewise varies, and apparently under the same conditions. It seems altogether probable that the two facts may be considered as supplementary, *i. e.* that the same process of depauperating of the blood, which deprives it of its corpuscles in an earlier stage, lays waste those supplies laid up in the cells referred to (whether by their actual separation as blood corpuscles or simply desolving of the contained material is of little importance). These cells also are thus paralellized with the "oil globules" of *Copepoda.* In such copepods as *Cyclops* and *Canthocamptus*, which appear to have no differentiated heart, there are always present drops of colored fluid, which are most numerous in well-fed and pregnant specimens. These drops occupy the same relative position as the blood globules of other Crustacea, *i. e.*, they lie within a very thin membrane corresponding to the vascular walls of other animals. This membrane, in general, invests the alimentary canal, as can be very readily seen in the abdomen, where it encloses a considerable space about the intestine, which is filled with fluid, investing more or less completely the muscles and other organs. As there is no rapid circulation of blood, these "oil drops" are comparatively stationary, and yet are moved slowly by the constant contraction of the walls of the alimentary canal which, in the anterior part, or stomach, are thick and glandular, while in the abdomen they seem to be more fitted for respiratory function.

The above arrangement in *Cyclops* is correlated with its compact habit and thick carapace, and forms a simple starting-point for the study of the circulatory system in arthropods. It seems that the walls of the membranous blood cavity are themselves also, in places, furnished with muscles, so that the fluid is not dependent entirely on the vermiform or the peristaltic motions of the intestine for its escape from stagnation. If this be correct, we here have an indication of the origin of the central organ of the circulatory system.

But to return to Daphnia, the heart lies in the dorsal region over the intestine upon which it may be said to ride, as it were astride, though as we shall see, it is separated from the intestine by other organs. In *Eurycercus* this is most evident, as here the heart is more obviously bifurcate.

The heart and circulation in Daphnia has been described more or less at length by many authors, in particular *Claus* (Zur Kenntniss der Daphniden und verwanter Cladoceren. Zeitsch. f. Wiss. Zool. Bd. xxvii.) and *Gruithuisen* (the work of this author I have not seen), while *Weismann* (Ueber Bau und Lebenserscheinungen von Leptodora hyalina, 1874) describes the heart of Leptodora, and *Claus* (Zur Kenntniss des Baues und der Organ. der Polyphemiden), that of the Polyphemidæ. Other authors, except *G. O. Sars*, who elucidates some points in the circulation of blood in Sida, seem to have added little or nothing to our knowledge of this interesting subject.

As already often described, the heart occupies a place in a definite space—*the pericardial chamber*—the summit of which is the dorsal shield which, we believe, should be distinguished from the remainder of the so-called cephalic shield. (It is usual to describe the shell of Daphnia as consisting of a bivalve posterior portion or *ormostegite*, and a simple anterior *cephalostegite*; but it seems much more proper to consider that portion of the shell which covers the pericardial space, and is the point of attachment of the powerful muscles of the abdomen and of the membranous walls of the pericardium, as a distinct portion of the carapace, as it often evidently appears through the presence of a distinct suture, or, in its absence, through the peculiar sculpture of the shell. In such case it might also be proper to distinguish two regions on the lateral appendages of this dorsal shield, an upper and a lower, separated by the more or less obvious line, extending from the union of the lateral lines of the dorsal and cephalic shield in nearly a straight line toward the posterior portion of the shell, and indicating the insertion of the muscles which move the feet and post-abdomen. The lateral walls of the pericardial space are the shell-walls themselves, and the floor is formed by a membrane supported on, and investing in part, the strong muscles which connect the abdomen with the upper anterior part of the dorsal plate. Thus a space is left between the pericardium and the intestine which is occupied by a special blood sinus leading toward the posterior and lower part of the abdomen. The posterior wall of the space is formed by a chitinous partition which bounds the brood space, or its homologue, and is connected by chitinous processes (stutzbalken) with the outer skeleton. The anterior, on the other hand, is only bounded by the supporting ligaments of the abdomen above described and membranous partitions. As usually described, the heart lies suspended in the cavity thus defined, by slender muscular threads, more or less like those of the heart of *Corethra* larvæ and the like; and such seems to be the case at first, but a more careful study shows that this is far from correct. On the contrary, the chief supports of the heart are membranes which, seen in cross-section with the attached grains or blood globules, assume the appearance of exceedingly slender structureless threads. The action of re-agents indicates that these supposed threads are not muscles, but composed of connective tissue; while by changing the focus the sharpness of the line is frequently not altered, but *its relative position is changed*,—a simple test which often serves to dispel an illusion of this sort. That there are some threads of the character above mentioned is not to be doubted, as in connection with the valves of the heart; but the proper support of the heart is found in the membranes which invest it in part, and are reflected upon the walls of the shell and, anteriorly, of the intestine. It is not yet possible to fully describe the insertion of these tissues, as there is so large a number, especially about the anterior opening, where they lie in all directions and at all angles, and are so transparent, that only their vertical sections appear as dark lines. Thus the same membrane appears and disappears, only to re-appear in a different position where it might be readily taken for a distinct membrane. In general, however, I hope to make no serious error in the following summary. Before going into detail, however, it will be necessary to consider the intimate structure of the heart, as well as its general shape and position.

The general shape is that of an irregular oval with the greatest convexity posterior (*Daphnia, etc.*), or it may be strongly bifid and thus somewhat Y-shaped *(Eurycercus, etc.)*. It is held in position in the pericardial cavity by the membranes above alluded to, to which it is attached at definite points, the principal of which are two slight enlargements on the lower posterior portion, which are in part opposed to each other and also to a superior posterior point of insertion. All three of these points are thus held in relation with the shell with which the attached membrane is connected on either side below and above. The membrane then extends part way along the heart wall towards the anterior and is then reflected to the shell wall. The result of this is that the pericardial space is an angular cavity opening in front. It would seem as though the membrane attaching the heart were identical with that lining the cavity itself. The heart proper is obviously composed of series of muscular elements, which are considered as simple cells by Claus, and which in young individuals show very destinct nuclei of comparatively large size. These are arranged like the meridian lines of a globe uniting above and below, thus forming the most effective apparatus possible for contracting the heart. In the smaller Daphnidæ, as stated by Claus, there seems to be but a single layer of muscular rays, but in D. schæfferi and Simocephalus I have repeatedly satisfied myself that some of the longitudinal rays sink below the others and form a series of *longitudinal muscles*, as stated by earlier writers. These are furnished with a nucleus which is frequently more or less external, appearing like a spherical appendage. In *Leptodora* Weismann has shown the heart to consist primarily of a membrane of connective tissue, upon which the muscular fibres or cells sit in somewhat the same position as in Daphnia, except that there is not the same regularity in the arrangement. There are many considerations which would lead us to expect the same structure in Daphnia, though it is not yet demonstrated; and the structure of the anterior opening seems to point in the same direction. At any rate there is a close connection between the muscular and connective parts of the heart. We have, then, in the heart of Daphnia a highly developed apparatus for closing it, but apparently none for its opening. This certainly is not accomplished by the few fibers which connect the heart with the shell, the very contractility of which is doubtful. Nay, more, these are insufficient even to hold it in its place in the cavity. Still less can we assume that the heart, from any inherent power, can open itself. This must be explained by the operation of two factors which are interdependent, *i. e.*, the elasticity of the supporting membranes and the unequal pressure of the blood in different parts of the body. 1. The membranes which support the heart are attached not at right angles, but, on the contrary, in a direction more nearly parallel to the walls of the heart, and thus whatever elasticity they possess is greatly increased; and the diminishing of the size of the heart draws these membranes out of their position at the expense of their elasticity, which tends to restore them to their original position when the pressure is removed, in the same way a drum-head returns after a blow to its normal position. This factor is, however, only operative so long as the whole system of membranes to which these belong is distended with fluid. If this blood cavity be punctured, the fluid flows out and the heart shrivels. It may continue to beat for some time, but it will be seen that the effort consists simply in a vigorous contraction which is followed by no perceptible enlargement. 2. After the systole the blood of the heart is forced toward the head, whence it is prevented from re-entering the pericardial space directly by the valves and the membrane enclosing the arterial blood. The pressure is therefore increased in all parts of the system, except the pericardial chamber where it is greatly, diminished. The membranes supporting the heart are thus unusually tense, and the muscular effort having ceased, the walls of the heart are distended, and blood flows in in the direction of the least resistance through the two lateral openings or ventral valves of the heart. The contraction of the heart during the systole is not simultaneous in different parts, but begins by the contraction of the posterior part where, being nearly free, the motion is more marked. At the close of the systole the heart is irregularly contracted, the points of attachment above described being more distended than the remaining portions. The anterior of the heart is rendered very difficult to study by the fact that its opening is covered by the muscles of the mandibles and obscured by the many supporting and vibrating membranes alluded to.

It is, however, suspended by two folds of membrane which I have been inclined at times to believe blood-vessels through appearances resulting from the confused currents flowing about them. The upper margin is also attached by a pair of cords directly to the superior part of the shell. The anterior opening or arterial valve is most perplexing, and the following description which applies only to Daphnia schæfferi must be subject to some doubt. It appears however that it has been in a measure misunderstood by previous writers, and namely by Claus, who compares it with that of Leptodora, which if correctly described by Weismann, is not at all identical in form, but quite comparable with one of the sides or lips of the venous opening. It does not seem to be connected by a thread, as stated for *Leptodora*, with the aortal bulb, for in reality there is no aortal bulb; the heart simply is connected with the system of membranes which more or less inclose the system. The floor of the so-called aortal space is a membrane which separates the outflowing stream from a current which flows toward the abdomen and passes directly under the arterial opening, so that it appears as though there was a stream entering the heart from before as well as at the sides; the arterial opening being nearer the dorsal part of the heart than is naturally expected, and the slight enlargements at the attachment of the supporting membrane favoring the impression that there is here a veritable opening. The out-flowing blood stream is bounded at first by the membrane above mentioned, which is farther on reflexed onto the shell and intestine so that the streams in the head flowing just under the shell are separated from the deep dorsal stream flowing from the heart.* This main current passes to the region of the eye between the horns of the cæca of the alimentary canal, and thence beneath the stomach, and here divides, part becoming external and a deeper part passing under the intestine, thence in front of the heart, flows into the deep sinus which, as before said, passes beneath this organ. Other portions of the returning stream flow around the angle of the union of the head and body and constitute a stream just above the feet in which the current flows vigorously.

Yet other portions flow into the region of the shell-gland and are united with blood which here passes through the numerous sinuses described by Claus as surrounding this organ (Die Schalen-

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*In *Pasithea rectirostris* this septum is easily seen as a swaying membrane, which near the eye is reflexed to the top of the shell.

druse der Daphnien) and thence flows into the abdomen, uniting with the other two streams. A part also of the current in the head flows into the antennæ where it follows a deep course through the basal joint in which the corpuscles may be seen to emerge to the surface from two points where are spaces between the powerful muscles, the first being near the base and the second near the extremity of this joint, and then to return and join the superficial current.

The corpuscles appear to enter the rami very rarely if at all. That part of the superficial stream which reaches the interior of the pericardial chamber passes between the muscles of antennæ and jaws and seems to find its way into the great current beneath the heart, though I have also thought to have seen it flow directly into the pericardial space as the lateral superficial streams do. That part of the superficial stream which reaches the posterior margin of the shell returns through a canal formed by the walls of the shell and the brood-space,between the"stutzbalken"of which the blood corpuscles can be seen to glide more rapidly than in the free lateral spaces.

Lastly,it only remains to follow the fortune of the strong stream flowing along the neutral surface of the abdomen. The strong current flowing beneath the heart enters a broad sinus which lies over the intestine and extends for over a third of its length, where its walls unite with the surface of the intestine above and thus open downward on either side.

The stream thus directed flows toward the openings of the base of the feet. The structure of the branchiæ has not yet been clearly described. Instead of nearly spherical or oval chambers they are really tubes which connect, on one hand with the opening above, and below with the general cavity of the limb, whence the blood returns to the abdomen. The current is very rapid through these tubes. The blood having been returned to the abdomen, courses in the well known manner through the post-abdomen and flows over the intestine, thence over the back-flowing stream to the posterior lower opening of the pericardial chamber.

The study of the actions of the heart is rendered more difficult by the fact that in order to secure the greatest possible transparency, the living animal must be covered and a little pressure applied, which is frequently attended with abnormal variations of the circulation. In particular if the usual exit of the blood be stopped by the cæca of the intestine, as is frequently the case, the operation of the heart may be reversed, when a vigorous stream may be seen to enter the arterial opening and emerge from the ventricles. This process would be impossible if the anterior valve were as described by Claus and Weismann; while being really more like the venous valves, it is easily and frequently permitted. The current of the blood in this case stagnates except near the heart.

The rapidity of the pulsations of the heart varies with age and condition of rest or motion.

In D. schæfferi this variation may range from about 150 per minute to perhaps 250, 200 being probably a fair average. In a young Simocephalus I have observed a heart beat 300 times in a minute. Again, in a specimen of D. Schæfferi at rest the heart was beating 170, but during the spasmodic motion of feet and antennæ the pulse rose to over 200.

I.—GENUS MOINA. Baird.

The systematic position of this genus has been the theme of some discussion. it being claimed, with good reason, that there are many resemblances to the Lyncodaphnidæ (P. E. Mueller considers it a transition to the Bosminidæ and lyncodaphnids); on the other hand, Leydig and Kurz regard it more closely allied to the Sididæ, with equally good reason. The long antennæ, long narrow antennules and many peculiarities in form, etc., suggest the macrothroid crustaceans; the extended abdomen and especially the location of the male seminal opening are like Daphnella, which Moina resembles in motion and habit very strikingly. The absence of the pigment fleck is no more a characteristic of the Sididæ than of other groups. After all has been said, the immediate affinities of the genus are acknowledged to be with the Daphnidæ.

The true place of the genus, as it appears to the writer, was hinted at by Birge (Notes on Cladocera). Moina seems to be the pivotal point of the Cladocera, at least of the families above mentioned. Without going into phylogenetic speculation, it is suggestive that this genus can and does by preference live in very impure water and may therefore have had an early origin. From Moina diverges the stem of the Daphnidæ by way of Ceriodaphnia, Simocephalus and Daphnia. These two latter genera are intimately connected by Simocephalus daphnoides, Herrick. Scapholeberis is connected with Ceriodaphnia through S. angulata, Herrick. The Sididæ seem to diverge by the way of Daphnella, through which by means of Pseudo-sida the genus Sida is reached, and finally Limnosida, Latona and Holopedium. The relationships of the curious Polyphemidæ are less evident.

The Lyncodaphnidæ make an easy transition to the Lynceids proper, while the Bosminidæ are still quite isolated, but are suggested by Macrothrix pauper. The fact that Moina stands thus related to radiating groups is simply suggestive, but it *is* suggestive of its possible antiquity and synthetic character.

The three species of this genus stand very poorly distinguished from one another and their specific validity may be doubted.

The most exhaustive study of the embryology of the Cladocera was based on Moina. (*Grobben*, *Entwick d. Moina*, *etc.*)

The genus is characterized by Weismann and Gruber[1] about as follows:

Head prone; separated by a depression from the thorax; fornices obscure; rostrum none; pigment fleck absent; antennules of the female large, moveable, furnished with a sensitive seta near the middle, flagelliform; antennules of the male very large, hooked at the end. The setæ of the antennæ are all ciliate; the tri-articulate ramus with five setæ; posterior margin of the valves thicker in the median line; caudal setæ very large, about twice in the length of the animal; anus above the claws; feet of the first pair of the male with a strong hook.

Weismann has shown that both summer and winter eggs originate from groups of four cells, one of which only is transformed into the egg, the remaining three serving simply as a supply of nourishment for the egg, which absorbs it directly. Both eggs and nutrient cells develop from the epithelium of the termination of the ovary. The summer eggs have less yolk than the winter brood, and the yolk is bluish in the summer eggs and deep red in the winter eggs of Moina rectirostris; while in M. paradoxa the summer eggs have yellow and the winter set snow-white yolk. There are never more than two winter-eggs in any of the Daphnidæ, but there are as many as twenty summer eggs in some cases in Moina. In M. rectirostris only one winter egg is produced, which is one of the best distinctions of the species, as this is, perhaps, the only case. (*Naturgeschichte der Daphnoiden*, *Weismann.*) The first generation, springing from the winter eggs (impregnated eggs), is composed solely of females which reproduce parthenogenetically; the second brood contains sexual males and females, thus completing the cyclus.

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[1] *Ueber einege neue oder unvolkommen gekannte Daphniden*, *Freiburg*, 1877.

Sp. 1. **Moina rectirostris,** Mueller.

(Plate A. Figs. 2, 5, 8, 10, 11.)

A. Var. vera.	
Daphnia rectirostris,	O. F. Mueller, Latreille, Bosc, Desmarest, Schrank, Leydig.
Monoculus rectirostris,	Gmelin, Fabricius, Manuel, Jurine.
Pasithea rectirostris,	Koch.
Moina rectirostris,	Baird, Weismann, Kurz, Birge.
B. Var. brachiatus.	
Monoculus brachiatus.	Jurine.
Dapania brachiata,	Desmarest, Edwards, Leydig.
Moina brachiata,	Baird, Weismann.
C. Both varieties.	
Moina brachiata.	P. E. Mueller. Lilljeborg.

The only tangible difference between the two forms thus united is the fact that M. rectirostris produces but a single winter ovum and hence has a one-chambered ephippium, while M. brachiata has a two-chambered ephippium.

The head is separated from the thorax by a marked depression; there is a deep depression above the eye; the margins of the shell have few bristles. The post-abdomen, which extends far beyond the edge of the valves, bears about eleven hairy spines on either side, the lower spine being two-cleft at the end; the base of the claws bears a comb of small teeth, and the posterior margins are bristled. The ephippium is oval; and the single cavity in M. rectirostris has its longer axis horizontal, while the two cavities of M. brachiata are vertical. The depression above the eye is deeper in the males, in which sex also the antennæ are longer and bent at the middle. The seminal bodies are stellate. Length 1, 2 mm. The form is subject to the greatest variation due to the varying number of summer eggs. Birge finds this species abundant. I have found both this and the following species in various parts of the Mississippi valley from Mobile to the upper river region.

Sp. 2.—**Moina paradoxa,** Weismann.

(Plate A. Figs. 1, 3, 6, 7, 9.)

The species differs in a few very insignificant points from the previous one. The head is short and nearly evenly convex above, with no deep depression above the eye; teeth of terminal claws reduced to bristles which are only a little longer than the series extending down the claw as in the above species; the first

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[1] "Gruber and Weismann, ueber einige neue oder unvollkmmen gekannte Daphniden Freiburg, 1877

foot of the male is furnished with a long bristle; the lower shell margins are more bristly than in the previous forms; the ephippium has two cavities, while the seminal bodies are crescent-shaped.

Sp. 3.—**Moina micrura**, Kurz.

This form may be of specific value, but it is not sufficiently distinguished to make this certain. As described by Kurz, it seems to be smaller (1 mm.) and most to resemble M. paradoxa, which was not at that time described. The post-abdomen is short and has few (6) spines, while the terminal claws are short and smooth; the head has a sinus above the eyes; the eyes are smaller, with numerous lenses; the antennules are shorter (?) than in M. rectirostris; the mandibles are partly exposed, while the shell margin overlying is notched. Males and ephippial females were not observed. Not distinguished in America.

II.—GENUS CERIODAPHNIA, Dana.

The genus Ceriodaphnia is the successor to Moina, which some species greatly resemble; the post-abdomen, however, is shorter and has a habitus resembling Daphnia; the antennæ are smaller, and the shell is thick and coarsely reticulated.

Ceriodaphnia has the same general mode of life as Moina, living in muddy pools in late summer and bearing numerous broods which often greatly extend the brood cavity. The antennules are shorter but have a similar form; the male antennæ show a transition in the various species from forms adapted for prehension to such as are found in Daphnia. The brood cavity is closed by two ridges on the abdomen instead of one, as in Moina, or three, as in Daphnia.

The ephippium contains but a single ovum. In general, the form is oval or quadrate, angled but not spined posteriorly; head separated from the body by a deep depression; pigment fleck present; beak absent; antennules moveable, rather short; antennæ with the three-jointed ramus with five setæ; first foot of the male with a hook or flagellum.

The members of this genus are danger signals from a hygienic point of view, for they frequent water containing decaying matter; as many as 1,400 were counted in a single quart of such water. The genus is particularly perplexing, as the varieties named seem to be hardly entitled to specific rank and are so similar as to require great care to properly distinguish.

The following artificial key, it is believed, will assist in placing the specimens which may be obtained in America. There seems no reason to doubt that our fauna is very similar to that of north Europe. Of the twelve species here enumerated at least one-third may be synomyms and others of the remainder are with difficulty distinguished.

ARTIFICIAL KEY TO THE GENUS CERIODAPHNIA.

A. Shell irregularly striate.
1. *C. megops*, Sars.
2. *C. cristata*, Birge.

B. Shell with hexagonal meshes.
a. Shell with doubly contoured markings.
(aa) Head broad, short.
3. *C. pulchella*, Sars.
(bb) Head narrowed, depressed.
4. *C. rotunda*, Straus, (antennules normal.)
5. *C. alabamensis*, Herrick, (antennules elongate.)
b. Shell simply marked.
(cc) Claws with teeth.
6. *C. reticulata*, Jurine.
[7]. *C. dentata*, Birge.
(dd) Claws without teeth.
I. Antennæ very long.
8. *C. punctata*, P. E. Mueller.
II. Antennæ normal or short.
* Post-abdomen broad.
9. *C. laticaudatus*, P. E. Mueller. 1 mm. long.
[10]. *C. consors*, Birge. 0.5 mm. long.
** Post-abdomen narrow.
† Head not angled behind the eye.
11. *C. quadrangula*, Mueller.
†† Head abruptly angled behind the eye.
12. *C. scitula*, Herrick.

C. Shell reticulate with rectangular meshes.
13. *C. nitida*, Schoedler.
[14]. *C. textilis*, Dana.

Sp. 1. Ceriodaphnia megops, Sars.

(Plate A. Figs. 16, 20.)

Ceriodaphnia megops, SARS, P. E. MUELLER, KURZ. (The earlier synonymy is doubtful See note, page 26, Schoedler's Neue Beitrage zur Naturgeschichte der Cladoceren.

This species is one of the largest and most readily distinguished as well as rarest of the genus. Very characteristic is the fine anastomosing striation which breaks up into reticulation only near the shell margins. This species seems to form the transition toward Simocephalus with Scapholeberis, which, however, diverges along its own peculiar track. The length is sometimes 1 mm. The head is obscurely angulated in front of the antennules, which are large. The antennules of the male are long and have a hooked setæ at the end.

· Typical C. megops has not yet been found in America, but the following form takes its place.

Sp. 2 **Ceriodaphnia cristata,** Birge.

The description given by Birge would apply in almost every particular to C. megops, though he seemed to overlook the close conformity. The size is much less (0.7 mm.), and the post-abdomen seems more abruptly truncate; moreover the number of anal spines is less. The crest upon the dorsal margin may be the effect of prominences such as are described by P. E. Mueller; at any rate, in view of the fact that but few specimens were discovered, the suggestion lies near that C. cristata is the young or, at least, a reduced form of C. megops.

Found at Southampton, Mass.

Sp 3.--**Ceriodaphnia pulchella,** Sars.

(Plate A. Figs. 14, 19.)

Ceriodaphnia pulchella, SARS, P. E. MUELLER, KURZ.

Very much like C. reticulata, but smaller. Head large, turgid, and angled in front of the antennules, forming almost a right angle; fornices moderate; antennules rather large; shell oval, reticulated with double contour lines; post-abdomen of medium size, narrowed toward the end, slightly truncate, with about nine spines; terminal claws short, smooth. The flagellum of the male antennæ is but slightly hooked,0.5—0.6 mm. long. This species is not certainly identified from America, though a form with smooth claws and small fornices occurs with C. dentata in some places.

Sp. 4. **Ceriodaphnia rotunda,** Straus.

(Plate B. Fig. 1. Plate A. Figs. 13 and 23.)

Daphnia rotunda, STRAUS, BAIRD.
Ceriodaphnia rotunda, SCHOEDLER, SARS, P. E. MUELLER, KURZ.

As said by Kurz, this species is not easily mistaken; the small head (only paralleled by the following), the very evident reticulations and the broad abdomen give it a peculiar habitus which is unmistakable.

Head depressed, small, spiny below, not angulated; fornices prominent, thorned; body rotund, almost spined above; shell doubly reticulate; post-abdomen broad, with seven or eight anal spines; claws large, smooth. The male antennules are little larger than those of the female. I have not yet seen this species in America.

Sp. 5. Ceriodaphnia alabamensis, Herrick.

(Plate B. Fig. 2.)

(American Naturalist, May 1883. Plate v, Figs. 11, 12.)

This species was seen but once and is insufficiently known. The body is elongate, quadrate, the shell reticulated with double contour lines, the head very small and produced downward below the eye, which is very small, the antennules are longer than in any other species, obviously two-jointed, with a lateral seta; the antennæ are very long; post-abdomen long and rather narrow, with the margins nearly parallel, truncate at the end, with over nine anal spines; claws smooth, abruptly truncate. My drawing represents a daphnia-like set of processes for closing the brood cavity. Length 1 mm. (?)

Tuscaloosa, Ala.

Sp. 6 Ceriodaphnia reticulata, Jurine.

Monoculus reticulatus, JURINE.
Daphnia reticulata, BAIRD, LEYDIG.
Ceriodaphnia quadrangula, SCHOEDLER.
Ceriodaphnia reticulata, SARS, P. E. MUELLER, KURZ, HERRICK.

Head long, obscurely angled in front of the antennules; fornices very prominent; antennules small; post-abdomen of moderate size, rounded at the end, slightly tapering; about eight long anal teeth: terminal claws with a series of sharp spines at the base. The reticulations are sharp but simple. The flagellum of the male antennule is either straight or moderately curved. Kurz says that some varieties have the fornices blunt w[illegible] thers are sharp. I have seen only the blunt form which is then much like the next.

Sp. 7. Ceriodaphnia dentata, Birge.

This form differs from the above only in having the inside of the claws fringed with minute bristles (sometimes absent), the angle of the head being more marked and the fornices less prominent. It is difficult to say whether our Minnesota specimens most resemble this or the typical C. reticulata of Europe. They seem intermediate, some having fornices with an abrupt angle. It may be instructive to quote Kurz on the European C. reticulata—"Examples occur 0.8–0.9 mm. long, others on the contrary only 0.5–0.6 mm. long and combining with the smaller size some differential characters. In the larger variety I found the fornix obtuse, while in the smaller it extends in a sharp thorn directed upward and outward. In this small sub-species the secondary teeth of the claws of the post-abdomen seemed to be absent, though in C. reticulata 3–5 are constantly present."

Sp. 8. Ceriodaphnia punctata, P. E. Mueller.

(Plate A. Figs. 1-3.)

Head depressed, rounded at the end, not angulated, ornamented with minute spines within the hexagonal areas. Fornices slightly prominent, either smooth or spiny; antennules very long; shell rotund, reticulated; post-abdomen of medium size, width nearly uniform, truncate below at an obtuse angle; anal spines large, increasing toward the end; claws smooth. Length 0.7—0.9 mm.

Found as yet only in Scandinavia.

Sp. 9. Ceriodaphnia laticaudata, P. E. Mueller.

(Plate A. Fig. 22.)

Ceriodaphnia quadrangula, SARS, (fide MUELLER.)

Head small, depressed, rounded at the end, not angulated; fornices prominent; shell roundish, or sub-quadrangular, moderately reticulated; antennules rather large; post-abdomnen broad, narrowed from the middle to the end; the nine or ten small anal spines nearly equal; claws large and smooth. In P. E. Mueller's time males unknown. Length 1 mm. Specimens 0.6 mm. long from Minnesota agree in most respects, but the reticulation is very marked and irregular and the terminal claws are pectinate. This form constitutes a transition to the next.

A species related to C. laticaudata, but only half the size, was found in Clarke's lake, a small but very deep pool, containing a fauna like that of the great lakes. The appearance is like the small form alluded to under that species, but the claws are smooth, the head is slender and strongly angled behind the eyes, and the antennules are of rather large size. The fornices are not very prominent. The shell is large-reticulate and the abdomen is large and obliquely truncate, the anal teeth being very large and strongly curved. The only individuals seen were ephippial females measuring .55 mm. This may be.

Sp. 10. Ceriodaphnia consors, Birge.

This species differs from C. laticaudata in one or two points, being about one-half the size and having fewer caudal teeth. Birge says the abdomen is broad and obliquely truncate. The difference between being obliquely truncate and narrowed at the end in some circumstances disappears, so that really this species seems quite close to laticaudata.

Found in Madison, Wis.

Sp. 11. Ceriodaphnia quadrangula, Mueller.

(Plate A. Figs. 17-18.)

Daphnia quadrangula, O. F. MUELLER.
Daphnia reticulata, BAIRD.
Ceriodaphnia quadrangula, P. E. MUELLER.

Head depressed, rounded at the end, only slightly angled; fornices prominent, antennules large; post-abdomen narrow, of equal width for the lower half, rounded at the end, with about eight small spines; claws smooth, length about 0.6 mm. This species resembles a smooth-clawed D. reticulata.

Sp. 12. Ceriodaphnia scitula, (Sp. n.)

(Plate B. Figs. 5-7.)

One of the most abundant species of Ceriodaphnia in Minnesota is a large form much resembling C. quadrangula. The post-abdomen is exactly as in C. reticulata or C. dentata, which latter it resembles in having a sharp angulation in front of the antennules. The shell is oblong and heavily marked with minute, regular hexagonal lining; the upper angle is rather sharp. The head is closely appressed, the fornices are prominent and abruptly truncate at the tip, the eye is small, the pigment fleck also small; antennules short. The post-abdomen is of moderate size, narrowed toward the end and armed with about ten powerful curved spines; the terminal claw itself is large and curved, armed only with fine spines extending down the entire inner side. The size is 0.8—1.0 mm.; color pinkish, opaque; antennæ, especially, often bright pink. Male 0.6

mm., flagellum of the male antennæ long; sensory filaments lateral, also one anterior, lateral flagellum.

Distinguished from C. quadrangula by the prominent fornices, large anal spines, small reticulations, form of head and larger size.

A small variety resembling the above very closely is the commonest form in our larger lakes; the reticulation is commonly larger but less distinct, the head is depressed and narrowed, with a sinuous upper outline. The fornices are prominent and the form of the post-abdomen is exactly as in the last. The spines of the post-abdomen are very long and seated on small eminences. The length hardly exceeds .55 mm. The claw is densely ciliated, but not spined; these smaller forms have but few eggs (two). The young have a thorn on the angle of the fornices. Plate J. Fig. 1 represents the ephippial female of this species. There seems no reason to doubt that this is only a variety of C. scitula. The small form of C. reticulata mentioned by Kurz might be referred here, while the larger form with less prominent fornices is not so diffierent from the American C. dentata.

Sp. 13. **Ceriodaphnia nitida**, Schœdler.

Ceriodaphnia quadrangula, LEYDIG.

This species seems to be characterized by the quadrangular form of the meshes of the shell-markings and the presence of teeth upon the claws.

Sp. 14. **Ceriodaphnia textilis**, Dana.

This species is not sufficiently fully figured to allow of a suggestion as to its affinities.

Daphnia rotundata, Say, is very probably a member of this genus, though the description is hardly intelligible. "Body rounded behind; upper antennæ three-branched, a small spine above at the joints; lower five-branched; color white. Length 0.5." It is probable that we should read "upper branch of antennæ with three setæ", etc., in which case we may identify the above with Chydorus or the like.

III.—GENUS SCAPHOLEBERIS.

The genus Scapholeberis stands rather closely related to Ceriodaphnia, from which it is at once distinguished by the angled or spined lower posterior angle of the shell. The head is rather clumsy, and the continuation of the fornices runs toward the apex of the incurved beak, which commonly lies within the valves of the shell. The lower anterior angle has a prominence and there is a basin-shaped area inclosing the base of the antennæ, part of which lies on the shell and part on the head. This area is more strongly lined or reticulated than the rest of the shell. The lower margin is straight and terminates, in most forms, in a long scythe-shaped spine which is directed backward. The shell itself is usually indistinctly reticulate or unmarked, and commonly is deep colored. The post-abdomen is very like Ceriodaphnia or more as in Simocephalus; the anal spines are few and the older specimens have more than the young; the place at which additional spines are to appear is marked by prominences. The eye is of moderate size, the pigment fleck rather small and the antennules short and hidden by the beak. The antennæ are of small size and generally dark colored. The ephippium contains but one egg; the males do not have altered antennæ or feet. The sexual periods fall in early summer and in autumn, according to Weismann; the males appear but sparingly. The species S. mucronata is very abundant everywhere, while the others are less frequently seen.

Sp. 1. **Scapholeberis mucronata,** Mueller.

(Plate J. Fig. 5.)

Daphnia mucronata, Mueller, Leivin, Lilljeborg, Fischer, Leydig, Baird, Herrick.
Scapholeberis mucronata, Schoedler, P. E. Mueller, Kurz, Weismann, Birge, Herrick.

This well-known species with rather short spines below is found abundantly everywhere. In this country at least it is characterized by a dark color. The head is large, rounded in front of the large eye, serrate below and extending posteriorly into a roundish beak, back of which are the short antennules. The fornices are very short and rounded; a line connects the fornices with the beak by a sudden deflection downward; it sets off the area which forms a part of the basin of the antennæ. A second line springing from just above the termination of the fornices passes over the eye by a broad curve. The post-abdomen is truncate and bears beside the terminal claws four or more spines which rapidly decrease in size. The claws are minutely spined; the spines on the shell are of variable length, but do not exceed one-fourth the length of the remainder of the lower margin. This species ranges over all Europe and eastern United States.

Length 0.6 mm.—0.8 mm.

Sp. 2. Scapholeberis cornuta, Schœdler.

(Plate T. Fig. 6.)

Monoculus bispinosus, DEGEER.
Daphnia mucronata, var. acute rostrata. BAIRD.
Scapholeberis mucronata, var. fronte cornuta, P. E. MUELLER.

This species differs from the above only in having a sharp curved horn on the head in front of the eye. The use of this appendage can only be conjectured; but it may be that, like the curved beak of Ripophilus, it serves to clear away rubbish in the filth in which these animals frequently live. This form, be it variety or species, is not known in America.

Sp. 3. Scapholeberis armata, (Herrick.)

(Plate B. Figs. 10-11.)

Scapholeberis mucronata, var. armata, HERRICK.

A very beautiful and unique species, which possesses the extreme development of the peculiarities ot the genus. The head is shaped very much as in the previous species, the fornix is squarish, the basin for the antennæ is small. The upper lines from the fornix meet behind the eye; the form of the shell is as in the above, but the spines upon the lower margin are longer. The scythe-like spine on the lower angles of the valves is extremely long, falling little short, in extreme cases, of being as long as the entire lower margin, in others about one-half as long. There are the usual lines parallel to the lower edge of the shell. The specimens having the longest spines were found in fresh water about Mobile, Ala., but the species occurs in Minnesota and intermediate points, though sparingly.

Sp. 4: Scapholeberis nasuta, Birge.

Form much as in the last, head shorter, "prolonged into a rather sharp beak, at whose apex the continuations of the fornices unite. The beak does not project downward as in S. mucronata, but backward, and in its natural position lies between the valves." The usual reticulated and lined areas are present and the balance of the shell is covered with "small pointed projections." "The antennules are much larger than in S. mucronata, though they do not project beyond the rostrum." The pigment fleck is long and large; the post-abdomen is much as in the preceding species; the terminal claws have several fine teeth. The males have the opening of the vas deferens close behind the terminal claws; mucro short and blunt, length 1 mm. This species is very near the next, but differs in several particulars. It forms the transition to the next, which is the extreme of the genus in a direction converse to that pursued by the S. armata.

Sp. 5. Scapholeberis angulata, Herrick.

(Plate B. Fig. 9. Plate T. Fig. 7.)

American Naturalist, 1883.

Form as in the above, but comparatively larger; valves quadrangular, anterior margin strongly arched; head short, only slightly concave below the eyes; the beak is as in S. nasuta, but seems to be directed more nearly directly downward than in that species. The antennules are long and resemble those of Simocephalus. The pigment fleck is square and rather large; the antennæ are of the usual size. The reticulated areas are as in the other species. The post-abdomen is more as in Daphnia, not so squarely truncate and with five to seven large teeth; the first foot has one elongated jointed seta; the posterior angle of the shell has no spine, at most there is a somewhat prominent acute angle, the inner shell layer is armed at this point with some elongated teeth as in the corresponding situation in Simocephalus. On the whole, there is a similiarity to that genus in this as well as in the previous species. S. nasuta has a short spine and elongated pigment fleck; the present species has a squarish but rather large fleck and no spine; the post-abdomen has a greater number of spines than any other species. South of Tennessee river, in Alabama and Mississippi.

The species of this genus are predominatingly American, four out of the five being found in the United States; the fifth, moreover, is more often regarded a variety of one of the others; in fact, the absence of S. cornuta from America is one of the most important supports of the specific independence of the two forms. All the species delight in disporting themselves near the surface in sunny weather.

IV.—GENUS SIMOCEPHALUS.

Although a very well circumscribed group, this genus passes into the next rather directly by means of S. macrothroides. The connection on the other hand seems to be by the way of Scapholeberis, though there is a rather broad separation between even Scapholeberis angulata and any known Simocephalus. The enlarged spines near the angle of the shell and the form of the antennules as well as some other points, show a transition through that species toward the present genus. The general form is quadrate with the lower posterior margin sinuate; in young specimens the shell is nearly a perfect rectangle. The upper margin is produced more or less at the point of union with the free posterior margin and the shell is either arched or very abruptly angled above the prominence in old females. The head is produced into a projection at the eye while the beak proper is between the anterior margins of the valves; the pigment fleck is rather large and variously shaped. The fornices are larger than in Scapholeberis and extend to the front of the head over the eyes; the antennules have a lateral flagellum which is large and lance-shaped. The post-abdomen varies very little in shape; it is truncate and excavated below and very broad. The anal teeth are few, large, curved, pectinate; the claws are straightish and pectinate or spined; the labrum is shaped as in Daphnia; the anterior part of the stomach has the usual cæca.

The members of this genus are among the most abundant and conspicuous of the family and are more persistent during the changing seasons than any other form. S. vetulus, the commonest species, stands in the centre of the genus, while two extremes are expressed by the other members of the group.

The winter or sexually produced eggs are lodged in an ephippium or saddle-like modification of the shell, which is finely reticulate; while the shell is usually marked by fine anastamosing lines which, in some species, show clearly their derivation from a rather fine hexagonal marking.

The sexual periods, when males are produced, occur in autumn and spring. The males have few distinguishing characteristics, the form being that of the young female.

The opening of the vasa differentia is back of the anus, hence these ducts cross the course of the intestine. They have ejaculatory muscles about the lower part. The smaller species are frequently deeply colored with pink, purple and brown fatty deposits and the markings are more conspicuous than in the American Eurycercus, which is itself often brightly spotted with blue or purple. The aspect in the water is between that of Eurycercus and Daphnia.

The first mention made of any member of this genus in America is Say's description, repeated in Dekay's Crustacea of New York, of Daphnia angulata. This description which follows is quite sufficient to identify the genus, and indeed to indicate that either S. americanus or a related form is intended, but it is hardly competent to alter names the significance of which is quite clear.

"Sides striate with numerous parallel minute oblique lines; hind edge of the body with a prominent angle in the middle. Antennæ with four filaments on the upper and five or the lower branch. Color white or red. Length 0.1; stagnant water in the forests of the Southern States."

Sp. 1. **Simocephalus vetulus,** Mueller.

Daphnia vetula, BAIRD, HERRICK.
Daphnia sima, MUELLER, LATREILLE, BOSC, RAMDOHR, GRUITHUISEN, DESMAREST LAMARCK, M. EDWARDS, KOCH, GMELIN, MANUEL, JURINE, LILLJEBORG, LEYDIG.
Simocephalus vetulus, SCHOEDLER, P. E. MUELLER, KURZ, WEISMANN, CLAUS, LUTZ, BIRGE.

This commonest and one of the largest species is apparently distributed over the northern hemisphere and abounds in all the more shallow lakes. The head is rounded in front and is not angled between the prominence of the eye and the beak. The body is very large and not abruptly angled above, the spine of the shell being inconspicuous and high, so that the free posterior edges of the shell lack little of equalling the greatest hight of the shell. The shell is covered with minute dense striations which spring from the free edges. The pigment fleck is elongated in old specimens and the upper angle follows up beside the suture separating the antennary basin from the rest of the shell of the head. The antennules are ornamented with minute spines. At the lower angle of the shell are three curved spines which differ from the preceding filaments. The number of eggs which are produced at once is truly immense. Under favorable circumstances this species reaches a large size, falling little if any short of 3 mm. S. vetulus lives, by preference, among the leaves of aquatic vegetation. With us this species seems to live in the smaller pools as well as in lakes of some size. I am not able to see any difference in this respect between the various species.

Sp. 2. **Simocephalus serrulatus**, Kcch.

Daphnia serrulata, KOCH, LIEVIN. FISCHER, LILLJEBORG.
Simocephalus serrulatus, LEYDIG, SCHOEDLER, P. E. MUELLER, KURZ.

Head narrow, extending anteriorly into a sharp spiny angle in front of the eye. Dorsal line of the shell abruptly angled or curved posteriorly, projecting to form a broad obtuse spine behind;

this spine is serrate with sharp teeth and lies somewhat above the middle of the hight of the animal, so that the free posterior margins of the shell fall much short of reaching the greatest hight of the shell. Post-abdomen of the usual form, with the claws armed with two series of spines or bristles, the outer being much the larger; anal teeth curved or angled, dentate; pigment fleck triangular or rhomboidal. Length 2.0 mm., 2.5 mm.

I am not sure that the three following species are more than varieties; the first in particular is very close to the European type

Sp. 3.—Simocephalus congener, Birge.

My own observations of this form made throughout the Mississippi valley are not in complete accord with the description of Birge, but it seems improbable that there is any mistake in the identification. The very generally distributed form on which this species rests is subject to marked variations within certain limits. This species differs from S. serrulatus in the following points. The head, although prominent and spiny near the eye, is not angled between this prominence and the beak; in fact, it is either straight or simply curved. The pigment fleck is usually rhomboidal and only occasionally oval, triangular or irregular. In other respects the agreement is rather close; the terminal claws have two series of spines, one of which is larger (not, as said by Birge, equal); the outer series is not so much larger as in S. rostratus, but not nearly as inconspicuous as in S. vetulus. The terminal claws are rather evenly curved. This species is frequently colored with pink or brown markings. In old females the back is squarely angled above, forming a pocket for the eggs. The size falls short of that of the last species. I have found this species from the gulf of Mexico to Minnesota.

Sp. 4.—Simocephalus rostratus. (Sp. n.)

This form is of the size and color of S. americanus, and approaches nearest to Schodler's S. expinosus in general characters. The back is arched above but not abruptly angled; the spine is as in S. americanus but not so low. The free posterior shell margins are somewhat shorter than the greatest hight of the shell. The head is produced below the eyes in an angle like a right angle, which is not spiny. The lower margin of the head is excavated to form a right angle, and in front of the smooth antennules forms a very prominent beak, beyond which the antennules reach but a short distance. The terminal claws of the post-abdomen are straightish and are more heavily spined than in the preceding; the anal spines are doubly curved or geniculate. The pigment fleck is rhomboid or pentagonal; the antennules are smooth. The abdominal processes differ somewhat from the previous species, in which the second one is rounded above, for in this it is squarely truncate. This species was found only in shallow pools at Ocean Springs, Mississippi, and was very carefully compared with S. americanus which is also found there.

Sp. 5. **Simocephalus exspinosus,** Koch.

Head extending into an obtuse angle at the eye, pigment fleck rhomboidal. Shell without a spine; maximum hight of the shell greater than that of the free posterior margin. Caudal claws with an unequal series of spines; anal spines evenly curved. There is little to distinguish the above from this species save the geniculate anal spines and the presence of a blunt spine on the shell.

Var. congener, Schoedler,

has the lower outline of the head sinuate instead of angled.

Sp. 6. **Simocephalus daphnoides,** Herrick.

American Naturalist, 1883.

A curious transition form, found only south of the Tennessee river, was described in the American Naturalist in May, 1883, under this name. By an oversight a comparison made with S. americanus appeared as though made with S. vetulus. The general shape is oval; the greatest hight of the valves lies near the middle and not posterior to it as in all the other species. The head is short, depressed, rounded in front; the beak is wanting; the lower margin of the head is straight. The pigment fleck is small, oval or irregular; the fornices are small and short. The antennules are smooth.

The post-abdomen is narrow, shaped more as in Daphnia; the terminal claws are straightish and fringed part way with spines; the anal spines are slightly curved. The processes of the abdomen are long, as in Daphnia. The shell is covered by the characteristic striations and extends into a blunt spine. In every detail, almost, there is an approach toward the genius Daphnia, while the general result is sufficiently like Simocephalus. The lower angle of the shell is not armed with the peculiar curved spines as in all the other species. This species becomes over 1-10 inch long. In such old individuals the spine is nearly midway of the hight.

One could wish a trifle closer link to Scapholeberis than that furnished by S. angulata; but, on the whole, the position of this genus can not well be called in question. America has four species out of the six known and but one of these certainly identical with the European, though others are probably too closely related.

NOTE.—On p. 47 read *S. Americanus*, Birge, not *S. Congener*.

V. GENUS DAPHNIA.

Long considered the type of the family, this genus is most frequently seen, or, at least, is more conspicuous than any other group. It has already been pointed out that the forms here united are the extreme development of a diverging line. Simocephalus is the link connecting it with the typical forms of the family. As might be expected, this genus presents more puzzling problems than any of the others. It contains more peculiarities of structure and diversities of habit and development than any other of the genera. Here the sexual differences are most interesting. The young are hatched with a pendant appendage attached to the upper posterior angle of the shell, which soon becomes the rigid spine characteristic of the younger stages and males of the genus. The females almost immediately after birth commence the production of eggs by an asexual process. Groups of epithelial cells containing four each are formed and one of the cells of each group develops at the expense of the others, forming the egg. Many such eggs are laid simultaneously and deposited in the cavity between the shell and the dorsal part of the animal. The eggs are prevented from escaping by means of three long processes, of which the first is much the larger and curves forward. At stated periods in spring and autumn the males appear; the females of the generation in which occur the males have a tendency to produce eggs of a different sort charged with a different mission. At the same time the upper portion of the shell (that surrounding the brood cavity) becomes finely reticulated and pigment is deposited between its layers. This ephippium, as it is called, in allusion to its saddle-like form, is the case in which the winter egg is to pass the period of cold or drought which is to follow. The method of the formation of the ephippium is obscure and, in spite of the investigations of Lubbock and Smitt, considerable remains to be learned with reference to this interesting modification of the shell. Some rather careful study has been devoted to this subject by the writer, but it was unfortunately interrupted before completion. The most promising method of persuing the investigation is that of sectioning ephippial females in various stages with the microtome. A preparation of soap was employed with partial success as a medium for embedding, and figures of some of the many sections made are drawn on plate P. Figure 10 is a vertical section through the middle of an ephippium which has been cast off. The outer and inner shell layers are distinct and one of the eggs is divided in the middle. No pigment or protecting material was deposited in this case, which is the simplest possible. Fig. 9 represents a section just back of the head; it passes diagonally, severing the heart longitudinally (h). The intestine (a), the ovaries (g), the mandible (m), the labrum (l), and certain suspensorial muscles (?) are seen *in situ*. Only a portion of the ephippium is cut and the double layers enclose a large mass of protective matter. Fig. 8 is a vertical section through the middle of the animal, and the usual form of the ephippium is seen with its large amount of protective matter obscuring all else. Fig. 7 is a longitudinal section of an ephippium similar to that seen in Fig. 10. It is hoped to present at some more appropriate time a fuller account of the formation and process of moulting this saddle.

DEVELOPMENT OF DAPHNIA.

Although the careful researches of Claus and Grobben have added much to our otherwise rather meager knowledge of the development of the cladocera, there still remain many interesting points, particularly with reference to the individual species, which merit careful study.

The following observations relate to the single species (D. schæfferi) which was available during a short stay in Leipzig:

The winter eggs of D. schæfferi are two in number and are lodged in the well known manner in an ephippium.

The shape of these eggs is sharply ovoid, there being no distinguishable difference between the two ends. The position in the ephippium is not, as might be expected, with the longer diameter paralled to the axis of the body, but the posterior end is slightly elevated. This is undoubtedly due to frequent elevation of the abdomen between the valves during the extrusion of the eggs.

The color is dark green and the only protection as the egg leaves the ovary is a thick, tough shell which is at first so soft as to be susceptible to pressure. It is thus reticulated, apparently through the simple pressure of the walls of the ephippium.

The length is 0.43 mm.; width .33 mm. in the average, though eggs were occasionally found of an elongated form, measuring .48, .31 mm. The contents of the egg consist of spheres of greenish plasma of various sizes and fat or oil drops. These oil globules are not very numerous as compared with those of the summer eggs, and likewise never attain the dominant size seen in the latter. The various forms assumed by the plasma balls are perplexing but frequently result from the action of external agents. The cleavage stage was not seen, and if actual segmentation takes place, it must be inconspicuous as would be expected from the large quantity of yolk present. The differentiation of the blastoderm occurs very early, perhaps in the ovary itself, and the result is a tolerably uniform layer of prismatic cells. The egg now comes to a period of repose after the blastoderm has produced a second external envelope apparently by simple secretion.

This envelope consists of a fine structureless membrane. The egg, under ordinary circumstances, remains dormant during the winter in this most favorable stage. The reason for which is evidently the fact that the differentiation has proceeded to the extent of producing the greatest number of protective layers without materially increasing the complexity, and thus the sensitiveness, of the organism. Under favorable circumstances the development proceeds farther and near one pole appears a slight indenture of the surface which grows deeper and seems to form a true invagination. This blastopore, if such it really be, remains for some time, generally till the two "scheitel" plates appear. These "scheitelplatte" are formed by a simultaneous thickening and lengthening of the cells of limited areas on opposite sides of the egg, near the opposite pole from that occupied by the blastopore. The "scheitelplatte" are situated at right angles to a plane perpendicular to the blastopore. The nuclei of the cells of the "scheitelplatte" are nearly .0208 mm. in diameter, while those of the other blastoderm cells are about half that size.

The egg remains a long time in this stage, while the following stages are passed through quite rapidly till the embryo assumes its nauplius form. The remainder of the development agrees, so far as seen, quite fully with that of the summer eggs, to which we will now return.

The summer eggs vary greatly in size and number, but are nearly as large as the winter eggs. The number is sometimes reduced to two or three or rises to as many as fifteen or even more. In color the eggs also vary from green to brown. The fresh egg consists, as the winter egg, of two sorts of yolk spheres. The plasma or formative yolk contains colored globules of rather small size, distributed throughout the whole of the mass quite uniformly. The food yolk or oil globules assort themselves in two sizes; first, a few (generally three) very large oil drops, which persist throughout the ealier stages of the embryo; second, smaller globules of apparently the same character, which are quite numerous and form a very considerable part of the contents of the egg, In an egg of about .35 mm. in diameter, the largest of the smaller size of oil drops measured .029 mm. while the larger three exceeded .060 mm. The oil drops are distinguishable by their light refractive power, pellucidity and the intense dark brown or black color assumed when treated with osmic acid. The latter reagent affects the formative yolk but slightly. It will be seen that though the summer egg is nearly as large as the "dauerei" in some cases, yet the relative amount of formative yolk is more diverse than at first appears.

The great similarity between the two sorts of eggs in Daphnia schaefferi is throughout striking as compared with Moina, the only one of the Daphnidæ the development of which is fully studied. In the summer eggs I have not been able to see the complete segmentation described for Moïna. The following stages are much as described by Grobben. An invagination occurs and a median swelling appears on the ventral aspect of the egg.

Labrum and second antennæ bud out and are soon followed by the antennæ, mandibles and two pairs of maxillæ, after which the five pairs of feet soon appear. In an early stage there is present a basal palpus to the second antennæ, a fact not before observed, and this persists as the small two-bristled wart found on the basal joint of the antenna. It is a conspicuous object in the embryo and is thus a true embryonic organ.

The eyes of the embryo appear as two separate pigmented flecks which approximate and are covered with an oval refractive body, which later is penetrated by the pigment and divides to form the small lenses. Soon after this the shell grows over the eye as described for Moina.

The first indication of the shell appears as two folds of the maxillary region of the back, being thickest laterally. These grow forward and backward to form the cephalic and body shield. At a little later stage there appears a very interesting modification of the shell which stands in close relation to the growth of the brood sac. A slight protuberance appears on the margin of the shell in the median dorsal line and extends toward the abdomen. It grows much more rapidly than the other parts of the shell and, in a later stage, forms a comparatively enormous tail, which curves under the animal between the shell valves which now extend beyond the body. This "tail" extends well along the ventral margin of the shell and reminds, by its position, of the tail of a frightened dog. The true tail, or post-abdomen, is, in the meanwhile, well developed and is constantly kicking the useless protuberence of the shell upwards. As the animal leaves the egg this projection becomes straightened as in the young D. pulex, finally becoming the still considerable spine, though it is proportionately much shorter than in the embryo. The spine becomes shorter with successive moults and the mature form has only a slight rounded knob in place of a spine more than half the length of the body.

The use of the long spine in the young Daphnia is a matter of interest. Its length agrees pretty well with that of the brood cavity and it seems possible that it serves to prevent the shell from bending abruptly down when it is only partially removed during the moult and thus breaking off and so leaving a portion of the clothing of the brood-cavity therein to become a source of irritation. This is more necessary for the young since the brood cavity is narrow and the shell weak, so that while the outer shell is removed like a glove from the finger, it can not be pulled upward or downward, but directly backwards. It is well known that male Daphniæ often have the spine, while the females may have none, and here again it is possible that the narrower cavity over the abdomen requires this assistance, while this is not the case with the females.

The shell gland is early formed and the branchial lamellæ of the feet appear almost simultaneously with the feet themselves as distinct lobes. The branchial chamber is not a simple chamber, but is essentially a curved tube as can be very well seen in the last foot of the adult. This tube doubles upon itself and crosses in the manner of a loop and a constant stream flows rapidly through it.

The nervous system is, at first, paired from beginning to end and first unites anteriorly, the ocular ganglia fuse after the union of the two pigment flecks in the compound eye, then the cephalic ganglion is formed by the union of the two preœsophagal ganglia, the commissures passing about the œsophagus. I have not been able to determine if the subœsophagal ganglia become fused. From the anterior ganglia spring the nerves to the antennæ and jaws, which latter are the larger in the embryo, being exceedingly large nerves.

This key contains the majority of the genus, but falls short of completeness. The following species are uncertain. W. Schmankewitsch described as new *D. degenerata* and *D. rudis*, from salt or brackish waters. These he regards as degenerate forms produced by the inferior aeration of dense waters. The author does not appear to recognize the modern distinctions of genera so that, not having seen the work, even the generic position can not be definitely stated. His investigations seem to show that the proximity of salt waters influence the form of the body, or, perhaps, that there is a constant interchange between the sub-marine and fresh-water species. *Daphnia brevicauda*, Chambers, is an incorrectly figured and described Simocephalus.

KEY TO THE GENUS DAPHNIA.

Section I. Pigment fleck present.

A. Head short, equally rounded.
1. *D. psittacea*, Baird.
B. Head not regularly rounded, more or less beaked.
(a) Claws spiny.
I. Abdomen broad, series of anal spines nearly equal, neither head nor back keeled.
† A marked sinuosity in the posterior outline of post-abdomen.
2. *D. schæfferi*, Baird.
D. ovata, Sars.
D. pennata, Mueller.
†† No well marked depression.
3. *D. pulex*, Mueller.
4. *D. schœdleri*, Sars.
***D. hastata*, Sars.**
***D. obtusa*, Kurz.**
II. Abdomen narrow, shell keeled somewhat dorsally.
5. *D. minnehaha*, sp. n.
6. *D. carinata*, Sars.
(b) Claws nearly or quite smooth.
I. Head not crested.
7. *D. longispina*, Leydig.
8. *D. rosea*, Sars.
9. *D. similis*, Claus
D. lacustris, Sars.
D. cavifrons, Sars.
10. *D. hyalina*. Leydig.
11. *D. dubia*, Herrick.

D. pellucida, P. E. Mueller.
D. galeata, Sars.
12. (?) *D. lævis*, Birge.

Section II. Pigment fleck absent.

A. **Head but slightly crested.**
1. *D. longiremis*, Sars.

B. **Head strongly crested.**
2. *D. cristata*, Sars.
3. *D. cucullata*, Sars.
D. apicata, Kurz.
4. *D. kalbergensis*, Schoedler.
D. cederstromii, Schoedler.
D. retrocurva, Forbes.
D. vitrea, Kurz.
5. *D. magniceps*, sp. n.

SECTION I.

A. *Head short, evenly curved.*

Sp. 1. **Daphnia psittacea,** Baird.

Mentioned by SCHOEDLER, FRIC and KURZ.

This species is at once recognized by the head, which is very short and evenly curved, or nearly so, from the heart to the beak. The shell is high, oval, with a rather short spine. The fornices are wide and angled behind; the antennules are longer than in most species; the post-abdomen is very large, but narrows toward the end and has comparatively few anal teeth, which are of unequal size. This is one of the largest of the genus. Not yet found in America.

B. *Head more or less concave below, at least not evenly arched.*

Sp. 2. **Daphnia schæfferi,** Baird.

(Plate M. Figs. 1—4.)

Daphnia pennata, MUELLER.
Daphnia pulex, STRAUS, KOCH, (fide P. E. MUELLER.)
Daphnia magna, LILLJEBORG, LEYDIG, etc.
Daphnia schæfferi, SCHOEDLER, KURZ.

The largest species of the genus, is of an elongated oval and ventricose form. The spine is entirely absent in old females and of only moderate length in the young. The antennules of the male are long and have a very long flagellum. The post-abdomen is narrowed suddenly below the anus so that the spines consist of two sets; the terminal claws are spiny at the base. Although very similar to D. pulex, it may be recognized at once by the concavity of the dorsal margin of the post-abdomen. The plate will make any detailed description superfluous. A common species in Europe, but not yet found in America.

Daphnia ovata, Sars, seems probably this species, but Sars was troubled by Straus' mistaken reference.

Daphnia pennata of Sars may also be this species or, more probably, D. pulex. The Latin discription given by Sars is appended for convenience of reference.

Daphnia pennata, Sars.

"Antecedenti (D. pulex) simillima, caput autem a latere visum latius, rostro breviore, supra visum testa cetera parum angustius fere cordiforme, antice acuminatum. Processus anteriores duo disjuncti. Margo posterior postabdominis in medio sinulo parvo et infra hunc utrinque aculeis 16-18 armatus. Color ut in antecedente. Longit. 2⅓mm."

Daphnia ovata, Sars.

"Caput a latere visum ante oculum fere angulatum, margine inferiore leviter concavo in rostrum longum apicem versus attenuatum, extremitate tenuissima exeunte, spura visum ut in D. pennata cordiforme. Testa cetera a latere visa ovata, margine superiore et inferiore in femina adulta fere æquæs arcuatis, postice in medio spinam formans brevissimam vel omnino obsoletam. Processus anteriores duo abdominis disjuncti. Margo posterior postabdominis in medio sinuatus, utrinque aculeis 20-22 armatus. Color albido—flavescens vel-virescens. Longit. circit 8 mm."

Sp. 3. Daphnia pulex, Mueller

This commonest of our Daphnids is apparently circumpolar in distribution. I have found it in Alabama near the Gulf and it also occurs near lake Superior.

Oval, either elongate or short, spine springing from the upper angle of shell or in some cases near the middle. The spine is rather long in young individuals but becomes very narrow in older ones or entirely disappears. The abdominal processes are long, not coalescent, or slightly united at the base. The head is concave below and extends into a prominent beak. This species is either very variable or several species are frequently united under the term. Two types have been recognized in America. One, abundant in spring in smaller ponds in Minnesota, is rather short, arched above, and in old females with the spine situated near the middle of the posterior margin. This form is quite typical for the species and occurs from April to mid-summer. Another variety was found in Alabama in late autumn, and similar animals in mid-winter in lake Calhoun, Minnesota. This type has a much more elongate body, the very slender but rather short spine springs from the upper margin of the shell or is quite wanting. This longer form has the beak slightly arched so as to resemble a "Roman nose." The anal spines are less numerous (10-14 while typical D. pulex has nearly 20). The young of this form, which may be called

Daphnia pulex, var. nasutus, (Var. n.)

(Plate N. Figs. 1-4.)

vary much among themselves but, in general, resemble the young of the European form.

Daphnia pulex has been mentioned by a number of authors in America, Smith, Birge, Chambers and Herrick having noted its occurrence in various parts of the United States. *D. obtusa*, Kurz, is apparently only the spineless condition of the above or a related species. *No Daphnia* is without the spine through life; such a form would constitute a new genus at once.

Sp. 4. D. schoedleri, Sars.

Seems to resemble D. pulex very closely but differs in having the lower margin of the head nearly straight, terminating in a short straight beak. The spine springs from the middle of the posterior margin. The anal spines are 14-16 in number. Length 2.33 mm.

This name is applied by Sars to Schoedler's D. longispina which is not D. longispina of Leydig.

Sars' D. hastata is so insufficiently defined that it will probably be necessary to drop it from the list.

Sp. 5. Daphnia minnehaha, (Sp. n)

(Plate K, Figs. 1, 2; Plate L, Figs. 1, 2.)

This species, which occurs in small pools in autumn (affluents of Minnehaha creek, etc.,) closely corresponds apparently to Sars' Daphnia carinata but differs in numerous points. It, in fact, is more nearly related to D. pulex than the group under which that species is placed.

The form is oval, arched above, narrowed posteriosly, terminating in a rather short spine which curves lightly upwards. In males and young females the spine springs from the upper angle, but in old females having many summer eggs the spine is nearly median. The head is depressed, strongly arched and keeled slightly above the eye, which occupies the extreme end of the forehead. The keel of the head extends into a slight angle over the heart and continues down the back. In young females and in males the slight angle is replaced by a strong knife-like projection which extends into from 1 to 4 sharp teeth, the anterior tooth being directed forward. The males, in particular, have this feature emphasized. D. longispina has a somewhat similar projection but the more nearly related forms seem not to show this peculiarity. The beak is slightly curved and the lower margin of the head is slightly sinuate. The shell has the usual square reticulations and is usually very transparent but in peaty waters becomes brownish. The size is small but variable; 1.8 mm. is a common measurement. The post-abdomen is narrow, the claws are armed with four or more teeth and a series of lateral bristles. The anal spines are eleven or more in full grown females and decrease only moderately upward. The processes of the abdomen are distinct. The males are smaller and strongly carinated above and of the same form as young females The antennules are rather long, with a short lateral and a long terminal flagellum, which latter is more than twice the length of sensory setæ which are partially lateral. The first foot has a strong claw and a long flagellum, while the second feet have a small spiny hook. There is a single abdominal process which is not hairy as in D. pulex.

Sp. 6. **Daphnia carinata,** Sars.

Very similar to the last but, according to Sars, the claw has no well marked teeth, a short flagellum on the male antenna, and the abdominal processes are united at the base (which may indeed be sometimes the case in the above.)

D. cavifrons, Sars, has a prominence on the forehead and the lower margin of the head is strongly concave, otherwise hardly destinguishable save by the absence of the keel above.

Sp. 7. **Daphnia longispina,** Mueller.

D. longispina, O. F. MUELLER. BAIRD, LEYDIG. SARS, P. E. MUELLER, KURZ. WEISMANN, etc.

Oval, elongate; head large, rounded in front, lower margin somewhat concave; rostrum long. Spine very long, springing from the middle of the posterior margin. Post-abdomen attenuated toward the end. Terminal claws smooth or simply cilate, spines few. The abdominal processes are united at the base a very little. Flagellum of the male antennule hardly longer than the sensory setæ. The young have three teeth above as in D. minnehaha. There is a great deal of diversity of opinion as to the value of this name. Not that there is any doubt of the existence of a widely distributed form which in general is that intended by Leydig and others, but the variation is so great that the possibility remains that more than one species is included under the one title.

P. E. Mueller recognizes two varieties depending chiefly upon the length of the spine.

D. lacustris, Sars, is nearly related, if not a variety of the above.

Sp. 8. **Daphnia rosea,** Sars.

(Plate K. Figs, 10-12.)

In form very like D. longispina, this species, which is the only representative of this smooth-clawed, unkeeled group yet found in America, might perhaps be appropriately re-united with that species, but, as there seems little doubt of the identification with Sars' variety, as above, I prefer to use his name.

Body oval, moderately ventricose; head of moderate size, lower margin nearly straight; eye situated in the anterior prominence. The beak is not very prominent. The upper outline of the head is slightly concave above the eye or rather less convex. The head is separated from the body by a marked depression. The spine of the shell springs from the upper angle or is quite wanting. The post-abdomen is of moderate size, somewhat narrowed toward the end. The claws are smooth, the anal spines nearly equal, straight, about 14 in number. The abdominal processes are not coalesced or but slightly so. Length 1.50 mm. to 2.0 mm. The species was collected sparingly in a large gathering of D. pulex from a small lake in early spring.

The size and conformation of the abdominal processes is very variable and the long and very slender spine is frequently absent.

Sp. 9. **Daphnia similis,** Claus.

The description of this species, which was bred in confinement from eggs brought in mud from Jerusalem, I am, unfortunately, unable to quote. Judging however, from the figures which alone I now have access to, it belongs in the group of *D. longispina*, though in many particulars it resembles D. schæfferi. The form is elongate, the spine short and springing from the upper margin. The antennule of the female is very large and flagellate, while that of the male is like that of D. schæfferi. The flagellum and hook of the first foot of male are rather small.

We now come to a group of related species which are most difficult to circumscribe on account of their extreme variability. According to the view of Lutz they would all fall into the old D. hyalina of Leydig. More probably, however, some of these forms are of nearly or quite specific value.

Sp. 10. Daphnia hyalina, Leydig?

(Plate L, Figs. 3, 5.)

Daphnia longispina, HERRICK.

I have elsewhere given a brief account of the post-embryonic development of a species which agrees best with Leydig's figures of D. hyalina.

The lower outline of the head is nearly straight, the eye being always approximated toward it. In young specimens the head is sharp in front and crested. The lower margin of the head appears very long and the beak turns backward. The spine is very long in young forms but is short in old females. The male resembles very much the young female. The post-abdomen is narrowed toward the end, the terminal claws are smooth, the anal teeth few and the abdominal processes united. Our specimens are from Paducah, Ky., south of the Ohio river.

I do not know how to distinguish *D. lævis*, Birge, from D. hyalina, save that the abdominal processes are said to be distinct. Both forms were observed in the above mentioned gathering. If, however, Birge's figures are characteristic, he had a different variety before him from ours; it seems somewhat like D. galeata.

D. pellucida, P. E. Mueller, differs from D. hyalina in the presence of a series of small teeth on the caudal claws, and a more strongly curved beak.

It is just now brought to my attention that P. E. Mueller, in a late work, identifies D. pellucida with D. hyalina, though he still holds D. galeata distinct.

Daphnia galeata, Sars.

(Plate T. Figs. 7, 8.)

According to P. E. Mueller, this species differs from D. pellucida in the absence of teeth on the caudal claw, and, in one variety, by the acuminate head, which seems the only form for which the name is distinctive. Kurz found only the var. frons rotundata. According to Forbes, both varieties, the first of which he identifies with D. pellucida, occur in lake Michigan.

S. I. Smith finds both in lake Superior, and seems to have no doubt of their distinctness. One of the forms which I have seen differs a little from either of the above, and had a different habitat. Kurz has described the male, which has a very short flagellum upon the antennule. A single source for D. galeata was found in a small pool known as Clarke's lake. This is the more remarkable, as this species, which is almost confined to larger bodies of water, is found nowhere else in the vicinage of Minneapolis, while this minute lake, though as deep, perhaps, as any of the largest in the county (say 40 feet), contains a number of forms known otherwise only in the Great Lakes. Kurz's remarks on the specimens collected by him apply equally to these. Were the claws dentate, the animal would pass as D. pellucida. The young have no horn on the head. The spine of the shell is nearly as long as the whole animal in the young. The male of our form is 1.2 mm. long, excluding the spine which measures 47 mm. The flagellum is a very little longer than the sensory setæ, and there is a very minute lateral flagellum. A peculiarity of this species is the scattered thorny armature of the spine of the shell. There is but little change in the form of head with age. The form of the last feet is peculiar. The ephippium occupies comparatively a small part of the valves and the spine becomes very short and quite smooth. The sexual period occurs in September and October.

The above statements regarding D. galeata require a modification, for in another deep lake the writer has since secured the typical crested D. galeata with even a higher crest than that figured by P. E. Mueller. The head ends in a sharp angle. The single female seen was in company with the rounded variety and numbers of D. kalbergensis, which it resembles in many respects. Our fauna therefore is quite complete in these remarkable forms.

(See Plate U. Fig. 6.)

Sp. 11. Daphnia dubia, Herrick.

(Plate L. Figs. 7, 8.)

American Naturalist, 1883.

The life history of this form is insufficiently known, but there seems no reason for doubting that it constitutes a new and easily recognizable species. It is nearly related to D. hyalina, but the head is strongly crested all round and the eye is withdrawn, in young as well as old specimens, toward the middle of the head. This peculiarity is shared in this degree by no other Daphnia

The form is as in D. pellucida, but the spine is more slender and directed upward. The head is shaped much as in D. vitrea in the young, but is much less prominent. The older form has a shorter and more slender spine (none were seen in the ultimate or spineless stage). The head is more evenly rounded, but still well crested. The abdomen is very slender and the anal teeth diminish rapidly in size from below upward. The claws are very short and armed down the whole length with fine bristles. The abdominal processes are well united at the base in old specimens, so that the second seems a small process of the first. The shell is very transparent and the spine is longer than in any other Daphnid. In a young specimen the spine was 1. mm., the body 0.7 mm., and the head 0.4 mm. In this specimen the spine was slightly curved, the head elongate with a slight ridge in front. Another individual had the spine 1.1 mm. long, while the remainder of the animal was 1.3 mm. This specimen also had a knife-like hyaline ridge on the crest, which was obliquely truncate in front; it also had numerous summer embryos in the brood sac. The spine was perfectly straight and but slightly inclined upward. Older individuals have a rounded crest as figured and no ridge. The spine is relatively somewhat shorter but much more slender. The characters which most clearly distinguish this species are the well crested head, which in young as well as sometimes older specimens has a median hyaline ridge, the withdrawal of the eye from the margin and the very long spine. It resembles D. galeata in earlier stages. It is very much like D. lævis or, in other words, is in the group of D. hyalina; but the study of a considerable number of specimens from different localities convinces me that it can not be united with that species in any of its varieties. This species has only been found in autumn, Sept.—Nov., lake St. Croix and Richfield in Hennepin county.

SECTION II.

Pigment fleck wanting. Head crested. The small, hyaline species constituting this section, elevated by Schœdler to the rank of a genus (Hyalodaphnia) and by Sars to that of a subgenus (Cephaloxus), are chiefly residents of the deeper parts of our larger lakes. These forms, from their rarity, have been little studied and it is uncertain how far the assumed specific distinctions are valid.

Two species are known in America and they are not confined to large lakes.

Sp. 1. **Daphnia longiremis**, Sars.

Hyaline, compressed, seen from the side, rounded, lower margin strongly arched; spine long, straight, oblique. Head rounded, lower margin nearly straight, ending in a beak directed downward, acute anteriorly. Eye small. Antennæ very long. Length 1 mm.

The abdomen is said to be similar to that of D. longispina. From the brief description given by Sars it would appear that this species is characterized by a rounded and uncrested or slightly crested head. Though imperfectly described, it is here mentioned to direct attention toward any such species as may be found in America.

Sp. 2. **Daphnia cristata**, Sars.

Compressed, long. Head acute in front, strongly crested, lower margin nearly straight. Dorsal line of body little curved, spine long in the young, strongly curved. Head of male smaller, flagellum of antennule twice as long as the setæ; first foot well clawed. Length of female 1.33 mm.

Sp. 3. **Daphnia cucullata**, Sars.

D. berolinensis, SCHOEDLER.

Very like the above, but the margin of head is not straight below, is, however, extremely variable and ends in a sharp angle. The eye lies nearly midway between the heart and the end of the head and near the lower margin. The two anterior processes of the abdomen are united for most of their length. The flagellum of the male antenna is about as long as the terminal setæ.

D. apicata, Kurz, seems to be a large variety lacking the sharp spine of the head. In the main it agrees quite well. Although the post-abdomen is broader than figured by Mueller, the number of teeth corresponds with Sars' description.

Sp. 4. **Daphnia kalbergensis**, Schoedler.

(Plate U. Figs. 1—3).

Form oval, spine long. Head high, compressed, enormously elongated, beak obtuse. Eye small. Abdominal processes not united. Caudal claws ornamented with small setæ. Antennæ of male with a short flagellum. Length of head nearly equal to that of body exclusive of spine.

D. vitrea of Kurz seems not improbably a varietal form of the above though the crest is lower, the size is less and the post-abdomen is more slender and has fewer teeth; the differences are, however, hardly specific.

I am not convinced that either *D. cederstromii*, Schoedler, or *D. retrocurva*, Forbes, are really distinct species, although the latter, with its more strongly crested head, is said also to have a series of teeth on the terminal claw. Perhaps it forms with D. cederstromii the fifth and extreme phase of this group.

Since writing the above account of Daphnia kalbergensis this truly monstrous species has come to light in the vicinity of Minneapolis. The opportunity is thus afforded to verify the suspicion expressed above that a number of species must be united under this name. P. E. Mueller gives the following measurements for D. kalbergensis: head 0.9—1.0mm., body 1.0—1.1mm., spine 0.7—0.75 mm. Kurz for his D. vitrea gives a length of 0.85 mm. plus 0.25 mm., the length of the spine. Judging from his figure, the head would not measure over 0.35 mm.

Forbes says of his D. retrocurva that the head is two thirds as long as the body.

Our specimens measured as follows:

No. 1. 1.6 mm, head somewhat more than half the body and almost exactly like D. vitrea in form.

No. 2. Head 0.6 mm., body 0.9 mm., spine 0.5 mm.; about 9 anal spines. Head in this case moderately curved upward.

No. 3. Head 0.95 mm., body 0.95 or less, spine 0.5 mm.; or the head as long as or, indeed, considerably longer than the body and directed upward.

The males have the crest much lower, the spine longer, and the form of antennules figured by P. E. Mueller. In the older females the beak is elevated above the antennules, as remarked by Forbes, but in smaller individuals there is very little difference between our specimens and Mueller's figures.

The claws of the post-abdomen have, besides the row of fine teeth mentioned by Mueller, a cluster of sharp teeth just at the base.

Found, together with typical D. galeata and the rounded form, in a small deep lake or expansion of a creek not far from Medicine lake, Hennepin county, Minn.

Sp. 5. **Daphnia magniceps.** (Sp. n.)

(Plate U. Fig. 15).

The peculiar form figured in the Tenth annual of this survey seems indubitably new and is distinguished by the peculiar shovel-shaped head, which is scarcely crested but is broadest beyond the middle. The spine is long, the claws smooth, the abdominal processes united and the shell transparent. The eye is near the end of the rounded head and is large; the pigment fleck was apparently absent. Found with Daphnia minnehaha in a shallow swampy pool in autumn.

FAMILY BOSMINIDÆ.

The sole genus of the family, Bosmina, contains over a dozen nominal species which are among the most difficult to define of any cladocerans. The number is here reduced to nine and the probable position of the rejected species is indicated. This is not done because the author presumes upon the slender material at hand to revise the genus; but simply from the fact that the descriptions of the earlier writers do not permit a proper discrimination; so that this necessity is entailed upon any one who would give a birds-eye view of the members of the genus. The B. diaphana is founded upon a different twist in the antennules and no hesitancy is felt in uniting it with Sars' B. lilljeborgii. The other species, B. brevirostris and B. nitida, are omitted simply because there seems to be no way of separating them satisfactorily from B. maritima and B. obtusirostris respectively. Three species have been found in Minnesota, but practically no attention has been given to the genus here.

Bosmina macrorhyncha found in Egypt is not here included, its description being inaccessible to me.

B. lævis, Leydig, seems simply a smooth condition of other species. Whether B. curvirostris, Leydig, is or is not valid must, so far as I am concerned, remain at present doubtful.

GENUS BOSMINA.

A. Shell extending into a spine behind.

(a) Antennæ curved outward.

1. *Bosmina cornuta*, Jurine.

(b) Antennæ not curved outward,

I. Shell reticulated, at least in part.

† Flagellum midway between eye and the sensory setæ of antennæ.

2. *Bosmina longirostris*, Mueller.

†† Flagellum nearer eye.

3. *Bosmina maritima*, P. E. Mueller.

4. *Bosmina longispina*, Leydig. (B. brevirostris?)

II. Shell striate.

† Antennules long.

5. *Bosmina striata*, Herrick.

†† Antennules short.

* Rostrum long.

6. *Bosmina lacustris*, Sars.

** Rostrum short.

7. *Bosmina obtusirostris*, Sars. (B. nitida, Sars?)

B. Shell not spined behind.

(a) Shell strongly arched above.

8. *Bosmina lilljeborgii*, Sars. (B. diaphana?)

(b) Shell moderately curved above.

9. *Bosmina microps*, P. E. Mueller.

Concerning the identification of Bosmina longispina, Leydig, with B. brevirostris, P. E. Mueller, it must be said that the bow is drawn at a venture, for Mueller, in his paper on the Cladocera of Swiss Lakes, in a fit of absent-mindedness refers to B. lacustris, P. E. Mueller, citing p. 149 of Danmark's Cladocera. On the page in question are descriptions of B. maritima and B. brevirostris of which the latter is probably the one meant. Sars' B. lacustris seems quite different, being strongly marked by longitudinal lines, while Leydig says of B. longispina "shell striped and small reticulate," and P. E. Mueller says in B. brevirostris the shell is "utydeligt reticuleret" i. e. indistinctly reticulate.

The three species so far identified in America are B. longirostris, of which a figure is given (plate J, fig. 2,) B. cornuta and B. striata, which may possibly be yet identified with one of the European species, though it seems improbable. I have also seen a species like Leydig's B. lævis, but considered it a smooth variety of B. longirostris.

FAMILY LYNCODAPHNIDÆ, Sars, 1861; Herrick, 1881.

This is a rather small family with seven genera of minute animals which are abundant only in summer. Many and, indeed, most of the species are among the rarer of fresh-water crustaceans of this group, and a few are among the rarities which only now and then reward the collector. This family undoubtedly is the link connecting the Daphnidæ with the Lynceidæ, relationships to which are expressed by Macrothrix, on the one hand, and Lyncodaphnia, on the other.

The rank of this group as a family must be, of course, a matter largely of opinion. Sars was the first to adopt this view, sustained by certain curious transition forms leading toward Lynceidæ. Later writers seem never to have found these genera and the group was again included with the Daphnidæ. The writer, upon the discovery of the Lyncodaphnia, was forced to regard this group as of equivalent grade with the above mentioned families and again proposed the family name Lyncodaphnidæ.[1]

The genus Ilyocryptus is a little one side the normal course of the family and seems related to the lynceid genus Leydigia.

The waters of the northern United States are very rich in members of this family.

The aberrant family Bosminidæ finds its only connection with other Cladocera through this group by means of the remarkable Macrothrix (?) pauper; and here it is only vaguely hinted at in the elongated antennules and angled lower margin of shell, as well as the presence of certain bodies near the base of the antennules. It has been affirmed that none of the Lyncodaphnidæ have an ephippium, i. e. the saddle-shaped thickening of the shell walls to include and protect the winter eggs; but I have discovered it in the case of Macrothrix tenuicornis, Kurz, and presume it may occur exceptionally in others. Kurz says that Ilyocryptus has no moult proper, but this probably refers only to the European I. sordidus. The American species differs from the generic description given by Kurz, and may be different in this respect also.

In this family the regularity in the disposition of the setæ on the antennæ is broken and the fringing of these hairs serves the purpose of specific distinction. The antennules are always long and frequently differ considerably in the sexes. The pigment fleck is always present (Kurz is in error in denying its existence in Lathonura). In many forms there is no free posterior margin of the valves, while the lower is generally thickly beset with movable spines. The Lyncodaphnidæ will be distinguished from Ceriodaphnia, which they resemble, by their motion, which is a succession of quick bounds, while the broader Ceriodaphniæ hobble along as though heavily weighted by the enormous mass of eggs with which they are generally laden. The abdomen is usually short and the anus is behind the terminal claws, but in Ilyocryptus the claws are long and spined at the base. In the American I. spinifer the anal opening is elevated to a point nearly underneath the stylets, and there is a rudimentary anal cæcum as in Lynceids.

The males have the opening of the vasa deferentia in front of the claws, which may be absent; the antennules are also modified, being longer and curved. In Lathonura the abdomen is elongated posteriorly till it begins to suggest a transition to Polyphemus. The known genera and their distribution is as indicated below.

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[1] Notes on some Minnesota Cladocera. 1881.

Half of the known species are found in America; one sixth being peculiar to it.

GENERA.	Total number of species.	European.	Also American.	Only in America	Total American.
1. Macrothrix	4	3	2	1	3
2. Lathonura	1	1	1	......	1
3. Drepanothrix	1	1	....	....	....
4. Streblocercus	1	1	....	....	....
5. Acantholeberis	1	1	....	....	....
6. Ofryoxus	1	1	1	....	1
7. Lyncodaphnia ?	1	....	....	1	1
8. Ilyocryptus	3	2	....	1	1
Totals	13	10	4	3	7

I. GENUS MACROTHRIX, Baird.

Body oval, pointed behind; head broad; antennæ of first pair long, nearly straight, beset with spines, olfactory threads terminal; swimming antennæ large and powerful, propelling the animal by bounds; three-jointed ramus with a greatly elongated seta which is thorned and jointed; labrum with the basal joint enlarged, resembling that of Lynceids; first foot with a hook in both sexes; last foot with a long process (respiratory body); abdomen short; claws short; caudal stylets often with a bush of hairs at tip. The intestine is straight and without cæca in front or behind.

The first one to observe a member of this genus, apparently, was O. F. Mueller whose Daphnia curvirostris is usually referred to Macrothrix laticornis.

The name Echinisca was proposed by Lievin, but Macrothrix was applied by Baird in 1843. Four species are known, three of which occur in America and without doubt the fourth will ultimately be found. No males of this genus were known till 1877 when the male of M. laticornis was described and figured.[1] Nearly two years later the male of M. rosea was described from Wisconsin by E. A. Birge. Descriptions of the male of Lathonura are also given in both the above mentioned sources.

Sp. 1. Macrothrix laticornis, Jurine.

(Plate C. Figs. 7, 8 and 9.)

Daphnia curvirostris(?), MUELLER.
Monoculus laticornis, JURINE.
Lynceus laticornis, DESMAREST.

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[1] Gruber und Weismann, Ueber einige neue oder unvollkommen gekannte Daphniden. Freiburg.

Macrothrix laticornis, BAIRD, Ann. Mag. Nat. Hist.
Acanthocercus curvirostris (?), SCHOEDLER, Erichs. Archiv, 1846.
Daphnia curvirostris, FISCHER.
Macrothrix laticornis, LILLJEBORG, LEYDIG, BAIRD, P, E. MUELLER, FRIC, KURZ, SARS, LUTZ, CLAUS (Die Schalendruse d. Daphnien), NORMAN and BRADY (Monogr. Brit. Entom.), GRUBER and WEISMANN, WEISMANN, (Beitrage zur Naturgeschichte d. Daph.)

This is the commonest European species and is the type of the genus, showing its rather conservative position by the broad tip of the antenna which is a feature exhibited by embryos and young of other species. The shell has a warty surface and is toothed above, while the lower margins are fringed with long unequal spines in groups of threes or fours.

The form is roundish with a blunt posterior angle, the ventral margin being regularly curved. The antennules are short and enlarged at the end. The form is an irregular pentagon; a pair of slender spines sits at the angle near the base.

The swimming antennæ with the seta on the first joint of 3-jointed ramus very long. Post-abdomen truncate at the end, short, posterior margin beset with series of bristles.

Length of male 0.5—0.6 mm., of female 0.4 mm.

This is the smallest of the genus and will undoubtedly be found in America.

Sp. 2. **Macrothrix rosea**, Jurine.

(Plate C. Figs. 5, 6, 11, and 13.)

Monoculus roseus, JURINE.
Lynceus roseus, DESMAREST.
Daphnia rosea, M. EDWARDS, JURRELL.
Echinisca rosea, LIEVIN.
Macrothrix rosea, BAIRD, LILLJEBORG, P. E. MUELLER, BIRGE.

The body is sub-oval, terminating behind in an acute angle; the lower margin is less conspicuously spined than the last or the following; the antennæ are but slightly dilated at the end and nearly straight. The longest seta of the antennæ is longer than in the last, reaching beyond the tips of the terminal setæ; abdomen more slender, sinuate in front, beset with short hairs.

Length 0.6 mm, male 0.3 mm. The male has no claws on the end of the post-abdomen, and the antennules are curved and elongated. Figures 5 and 13 are copied from Birge.

Sp. 3. Macrothrix tenuicornis, Kurz.

(Plate C. Figs. 1, 1 a, 2, 3, and 12.)

(See Notes on Cladocera of Minnesota, p. 245.)

The body is oval, produced posteriorly in a sharp point; the abdomen is strongly arched, while the upper outline of the head is a regular curve or slightly extended in front of the eye; the antennules are long, nearly straight and a very little narrowed toward the end, just in front of which is a series of short teeth; there is no lateral spine, but a strong terminal one in addition to the sensory filaments; the pigment spot is large, the eye small and the lobus opticus well separated from the ganglion; the antennæ have a very powerful basal joint; the elongated seta is very stout and densely spiny, with a tooth at its flexure; two of the terminal setæ are spiny, for the basal half; the valves are beset with very long spines in sets of three each, all having different positions; the abdomen is nearly as in M. rosea, but the posterior margin has a series of long sharp teeth; the mandibles are nearly completely exposed by the arched anterior margin of the valves.

The labrum, in this species, is an odd link between that of the Daphnidæ and Lynceidæ. The basal segment is greatly enlarged and is sub-triangular in outline, with a movable lip attached to the inner free face; the typical daphnoid structure is preserved, but the enlarged salient angle of the basal portion shows how the transition to the great triangular labrum of Alona, etc., is made. In young specimens the head is proportionately larger, the antennules are broader at the tip, and the dorsal outline is less convex; the marginal spines of the valves are also proportionally larger, as are the appendages of the first and last pairs of feet. This is one of the largest species of the genus, 0.75 mm. being the length. This is very close to M. rosea but seems distinct.

This form is quite common about Minneapolis, Minn., but is not yet noted elsewhere in America.

Sp. 4. Macrothrix pauper, Herrick.

(Plate C. Fig. 4.)

This species is described from a single specimen from L. Minnetonka, and I can add nothing to the very meager notice given then.[1]

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[1] Notes on some Minnesota Cladocera. 1881. C. L. Herrick.

The body is broad and very narrow, the lower outline is angled and nearly unarmed; the pigment fleck and eye are small and approximated; antennules very long and curved backward and outward; abdomen short, ciliate below; claws short, ciliated. This female had a full complement of eggs but the antennæ resemble those of a male. This is unusually interesting and should be rediscovered and studied; for there seems to be some affinity between this species and Bosmina, and it is probable that it requires to be distinguished generically from Macrothrix.

II. GENUS LATHONURA, Lilljeborg.

The form is oval; the head is curved more than in Macrothrix and the shell is more obtuse behind, sinuate below where it is beset with short spines anteriorly; first antennæ long, straight; second antennæ with five setæ on each ramus; only four pairs of feet apparent; abdomen short, prolonged upward to the insertion of the caudal stylets; male similar but smaller.

Sp 1. **Lathonura rectirostris**, O. F. Mueller.

(Plate D.)

Daphnia rectirostris, O. F. MUELLER.
Pasithea rectirostris, KOCH, Deutschland's Krust., etc.
Daphnia brachyura, ZADDACH, Syn. Crust. prussicorum. LIEVIN, Die Branch. d. Danziger Gegend.
Daphnia mystacina, FISCHER, St. Petersb. Branchiop.
Lathonura rectirostris, LILLJEBORG, De Crust. ex ord. trib.
Pasithea rectrirostris, LEYDIG, Naturg. d. Daph.
Lathonura rectirostris, NORMAN and BRADY, Monogr. Brit. Ent.; P. E. MUELLER, Danmark's Cladocera.
Lathonura spinosa, SCHOEDLER, Branchiop. d. Umg. v. Berlin.
Pasithea rectirostris, GRUBER and WEISMANN, Ueber einige neue od. unvollk. gekannte Daph.
Lathonura rectirostris, BIRGE, Notes on Cladocera. HERRICK, Notes on Minnesota Cladocera.

The only species of the genus is distributed probably over the entire northern temperate zone. It has been found in America at Cambridge, Mass., and in the vicinity of Minneapolis, at both of which places it is very rare.

The form is a rather quadrangular oval, the head being strongly arched to the beak which is much farther posterior than in Macrothrix, in this respect resembling the Daphnidae; the eye occupies the center of the lower part of the head margin, and is of moderate size; the pigment fleck is near the base of the antennules and well removed from the eye; the antennæ are straight and long, with a sensory bristle near the base in front and two bristles a third from the end; the second antennæ are furnished with a powerful basal joint, while each of the main subdivisions of the rami has its bristle, which are nearly equal: two of the terminal setæ are toothed for the basal half and pectinate distally, but the others are feathered throughout; the four-jointed ramus has a spine on the second joint and a longer one at the end, and all the joints of both rami are ornamented with triple series of spines; the maxillæ are three-spined at the end and are in almost constant motion; the first pairs of feet have curious comb-like bunches on some of the setæ; the abdomen is very short and terminates in inconspicuous teeth, the posterior part of the abdomen being ornamented with teeth flattened longitudinally so as to look like spines from the side; the last foot is simple but bears a large appendage; the posterior third of the shell is fringed by extremely minute spines, but anteriorly by lanceolate stiff spines flattened longitudinally like the spines of the abdomen; the caudal setæ are seated on a high prominence of the abdomen, and are fringed along their whole length, not merely at the end. The female is 1 mm. long, the male 0.5—0.6 mm., in which sex the antennules have more numerous lateral bristles, the first foot has a claw and the back is less elevated. The semen bodies are irregularly round with small nuclei.

III. GENUS STREBLOCERCUS, Sars.

In form like Macrothrix laticornis, head terminating in a long rostrum bearing the long, twisted antennules. Antennules very large, curved backward and outward. Head not separated by a destinct depression from the body, very high, slightly arched above, abrubtly curved below with spines upon the margins. The antennæ are large; four-jointed ramus much the longer, with four setæ. Labrum with a large process. Post-abdomen as in Macrothrix laticornis. Eye near the beak; pigment fleck small, below it at the base of the antennules. Length .33 mm. S. minutus is the only species.

Our Macrothrix pauper seems a near approach to this genus; both have a strong spine or claw on the first foot which projects beyond the shell, but there are many differences. M. pauper is 1 mm. long.

IV. GENUS DREPANOTHRIX, Sars.

The head not separated from the valves by a depression; fornices moderate; rostrum rather acute, distant from the anterior edge of the valves. The form is subrotund; reticulate, with the margins of shell fringed below by long movable spines; pigment fleck present; swimming antennæ with three ciliated setæ on the 4-jointed ramus, the 3-jointed ramus with its basal joint armed with an unjointed, strong, spinous seta and four ciliated setæ on the remaining joints. The post-abdomen is broad. The male has longer antennæ and a hook on the first foot.

Sp. 1. Drepanothrix dentata, Euren.

(Plate C. Fig. 14.)

Acantholeberis dentata, EUREN.
Drepanothrix setigera, SARS.
Drepanothrix hamata, SARS.

This animal is only 0.5 mm. in length. The antennules are laterally curved in the middle and ornamented with notches on the margins; the pigment fleck is quadrate and rather large; the post-abdomen is truncate at the end, convex behind and ornamented with a series of small spines. Only found in Scandinavia as yet.

V. GENUS ACANTHOLEBERIS, Lilljeborg.

Head separated by a depression from the body, with fornices above the base of the swimming antennæ; rostrum erect, rather acute; shell oblong, truncate behind, ciliate below with long setæ; macula present; antennules rather long, movable, sensory setæ terminal, bifid at the apex.

The tri-articulate ramus has a long spiny seta on the basal joint; feet six pairs; no abdominal process; post-abdomen wide, large; intestine without cæca.

Sp. 1. Acantholeberis curvirostris, Mueller.

Daphnia curvirostris, O. F. MUELLER.
Acanthocercus rigidus, SCHOEDLER, LIEVIN.
Acantholeberis curvirostris, LILLJEBORG, P. E. MUELLER.

This species of a genus approximating the Lynceids has not yet been found in America but is to be expected.

The abdomen is rounded toward the end and spiny posteriorly; the terminal claws are furnished with two strong teeth at the base, followed by a series of fringing bristles. The length, according to Mueller, is 1.5 mm. This is a rare form in Europe.

VI. GENUS OFRYOXUS, Sars.

The single species constituting this genus seems to have been seen by no writer save Sars. At the time my previous paper on Cladocera was published, Sars' description seemed not to apply to the form called Lyncodaphnia. Since then several stages in the growth of Lyncodaphnia have been encountered, which so far agree with what is said of Ofryoxus gracilis that it is doubted if the two forms are not identical.

VII. GENUS LYNCODAPHNIA, Herrick.

(Plate B. Figs. 12, 15; Plate B1, Figs. 1, 3.)

Body elongated, somewhat rectangular as seen from the side, greatest width and hight of shell a little posterior to the heart; head separated by a depression from the body, truncate below; antennæ and antennules much as in Macrothrix; 4-jointed ramus of antennæ with no lateral setæ; eye small, pigment fleck present; intestine twice convoluted, expanded posteriorly, with anterior but no posterior cæca, opening near the "heel" of the post-abdomen: post-abdomen large, triangular; terminal claws long, rather straight, with two accessory spines at the base.

The species upon which this genus was founded[1] occurs in August and September in the larger lakes of Minnesota.

Lyncodaphnia is, as was suggested, a curious transition form linking the Daphnidæ with the Lynceidæ.

A farther study of the genus shows that, in some respects, it is more closely allied to both groups than before suspected. The habit and appearance in the water reminds us of Simocephalus, a resemblance which an occasional spot of pink or blue color hightens. L. macrothroides not only has the disc-like last foot colored but the swimming antennæ are banded with purple as in Simocephalus rostratus, Her., and S. americanus, Birge. The intestine has anterior cæca, which is not the case in lynceids nor, indeed, in other Lyncodaphnidæ.

The four-jointed ramus of the antennæ approaches Lynceidæ in the absence of a lateral seta, but the other ramus is as in Macrothrix. The convolution of the intestine, the form of the post-abdomen and the situation of the anus, are all of a strictly lynceid type; moreover the flattened appendage of the last foot is like that of Eurycercus.

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[1] Notes on Minnesota Cladocera, p. 247.

Even in the form of the shell there is a combination of characters; the anterior part of the shell has the form peculiar to Lyncodaphnidæ; but posteriorly it again expands and becomes truncate behind; the form in the adult is not unlike that of some Lynceidæ, but the young has a long spine posteriorly exactly like the spine of Daphnia. The latter fact is very instructive, for it indicates that the theory proposed (Am. Naturalist, 1882, p. 815) to explain the origin of this appendage is probably the correct one. Professor Leuckart suggested that this spine was a balancing rod intended to keep the proper equipoise over the center of gravity; but it is difficult to see why these long-bodied forms, in which the greater part of the weight lies "abaft" of the pivotal point—the base of the antennæ—should be thus provided while the shorter forms are not. We conceive that it is an apparatus for effecting the moult of the inner lining of the brood cavity of long-bodied and tender-shelled animals such as Daphnia and the present genus. The great development of the head in the crested Daphnidæ may undoubtedly be explained upon Prof. Leuckart's theory.

Sp. 1. **Lyncodaphnia macrothroides,** Herrick.

(Perhaps = Ofryoxus gracilis, Sars.)

Notes on Cladocera of Minn., p. 247.

Sub-rectangular, greatly elongated, truncate behind, with a slight spine above; head and eye small, fornix moderate, beak truncate; antennules rather long, slightly curved, tapering a little toward the end, whence spring three lanceolate spines and several sensory filaments, five stout spines behind, above the middle, and several more slender ones; swimming antennæ very long, terminal setæ smooth to the joint; labrum as in Daphnia; mandible attached behind a salient angle of the front margin of the shell; no abdominal processes; post-abdomen broad above, triangular; terminal claws pectinate, furnished with one very large toothed accessory spine and a smaller one; the first foot has a hook ; the last foot consists of a large oval plate which bears posteriorly the ordinary branchial coil, here shaped like a thumb and forefinger. The young is of a different shape and bears a long spine. The male is unknown.

VIII. GENUS ILYOCRYPTUS.

Form compact, short; head short, triangular, with large fornices forming a roof over the head; the posterior margin of shell nearly as long as the inferior; lower angle a broad curve; antennules two-jointed, basal joint very short, second joint straight, rather long; setæ terminal, but one seta near the base; the four-jointed ramus of the antenna with but three (terminal) setæ; six pairs of feet, last pair rudimentary; tail large, as in Lyncodaphnia, anus elevated; intestine straight, without cæca, but an expansion near the rectum sometimes simulates one; the margin of the shell is bordered with long spines, which may be branched or simply pectinate. There is often, perhaps generally, a failure to entirely remove the moulted shell; when this occurs, the newly-formed shell from each moult remains under the older ones till the animal seems to be wearing six or more overcoats, and the spaces so formed become filled with algæ and filth till the animal is no longer able to swim. P. E. Mueller and Kurz, who seem to have seen only I. sordidus agree that Ilyocryptus can not swim, but poles along in the mud on the bottom by means of antennæ and abdomen; our I. spinifer, on the other hand, swims freely till loaded up with old clothes and filth.

This genus is also closely allied with the Lynceidæ.

Sp. 1. **Ilyocryptus sordidus**, Lievin.

(Plate C. Figs. 15, 16, 17.)

Acanthocercus sordidus, LIEVIN, LEYDIG.
Ilyocryptus sordidus, SARS, NORMANN, P. E. MUELLER, KURZ.

Body higher than long; head small, terminating anteriorly in almost a right angle; posterior part of the shell margins covered with branching, thorny spines; antennules cylindrical; antennae short: four-jointed rami with no lateral setæ; post-abdomen large, broad; terminal claws with two spines at the base; anus in the middle of the posterior margin, which is very heavily armed with spines; a hairy abdominal process is present according to Kurz.

There are no anterior cæca (my statement that P. E. Mueller described such cæca was an error; see Notes on Cladocera of Minn., p. 246).

Sp. 2. Ilyocryptus spinifer, Herrick.

(Plate C. Figs. 18—19.)

Usually longer than high; head rounded, almost exactly like I. sordidus, but the form of the post-abdomen differs a little in the higher situation of the anus and the great elongation of four or five of the lower spines of the posterior margins; the margins of the shell are beset with pectinate setæ which do not branch. The nearest approach to branching setæ yet seen are figured on plate C, fig. 18a; this consists in the outgrowth of a spine from near the base, and such setæ are found only on part of the posterior margin.

It seems that our form is rather close to I. sordidus though clearly distinct.

This species occurs in many of our lakes, and is found most frequent in late summer.

Sp. 3. Ilyocryptus acutifrons, Sars.

This species is only mentioned in the appendix to the paper of Sars on the Cladocera from the vicinity of Christiania. The following is a condensation of the description.

Head large, acute in front. Shell truncate behind, with shorter setæ behind than below. Antennules shorter and thicker than in I. sordidus. Antennæ long and robust. Abdomen with a short, obtuse process. Post-abdomen shorter than in I. sordidus, posterior margin continuous, anus terminal; caudal claws straight, very long, with two minute basal spines. Pigment fleck almost touching the eye. Length less than in I. sordidus.

This species seems in some respects more like a true lyncodaphnid than either of the other species. It is doubtful if it belongs here.

FAMILY LYNCEIDÆ.

GENERA.	Number of known species.	European.	Also in America	In America only.	Total American.
1. Eurycercus	1	1	1	....	1
2. Acroperus	2	2	1	....	1
3. Camptocercus	6	5	1	1	2
4. Alonopsis	3	2	1	1	2
5. Leydigia	2	2	2	....	2
6. Graptoleberis	2	2	1	....	1
Crepidocercus	1	....	....	1	1
Alona	21	14	6	7	13
9. Alonella	5	5	2	....	2
10. Pleuroxus	14	8	1	6	7
11. Harporhynchus	1	1	....	....	....
12. Chydorus	8 (?)	6 (?)	3	....	3
13. Anehistropus	1	1	....	....	1 (?)
14. Monospilus	1	1	1	....	1
Totals	68	50	20	16	37

Out of the fourteen genera, two (or perhaps only one) are not yet known from America, while one is restricted to it. The American species, 45 per cent of which are new, aggregate 72 per cent of the European. 54 per cent of all the known species are American, and most of these have been found within a range of ten miles of Minneapolis. It is probable that the number of species peculiar to America is too high proportionately rather than the reverse, and the comparatively high per cent of new species is due to an actual larger fauna in the New World, while many Old World species remain to be identified. A few of the European species are very likely synonyms, permitting farther reduction.

This family, which is numerically the largest among the Cladocera, is, in the main, well limited, though there are transitions toward the Lyncodaphnidæ, which are quite direct. The genera Lyncodaphnia, Ofryoxus and Ilyocryptus lead toward the Lynceidæ unmistakably. Most of the members of this family are small, comparatively few exceeding one millimeter in length. The head is covered with an arched shield, which frequently passes with no indentation into the shell of the body. This head-covering generally extends forward and downward to form more or less of a sharp angle in front, while in several genera it is simply rounded in front. It, in either case, arches over the more fleshy lower side of the head from which hang the two short antennules and the labrum, while the strong two-branched antennæ spring from well up under its posterior expansion. The rounded sides of this shield, which protect the insertion of the antennæ, are called the fornices. Above the insertion of antennules is a dark fleck lying near or on the lower angle of the brain; this is the larval or nauplius eye, which is the first to appear in all these small crustacea. This *macula nigra* is not infrequently as large as the eye itself,* or even larger, and in one genus it is the only visual organ. The antennules are small and bear on the end several sensory filaments as well as a lateral flagellum. The antennules of the male differ very little from those of the female. The labrum is furnished with a process, which is triangular or semicircular and is usually larger than the terminal portion. The mandibles are as in Daphnidæ but usually shorter. Maxillæ are often conspicuous, but the first pair of feet serve, by a slight alteration at the base, the same purpose. There is rarely an indication of the sixth pair of feet, and the antennæ have both rami three-jointed. The terminal part of the body, or post-abdomen, is usually enlarged, and the anal opening is near its base; the armature is usually considerable. The form of the post-abdomen is one of the best criteria for distinguishing genera and species—a process often attended with much difficully.

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* The name "Lynceus" is derived from that of the son of Aphareus who was famous for the sharpness of his vision.

The shell is of various forms, frequently beautifully sculptured. The number of eggs produced at one time is limited, and the winter eggs are very often laid in the brood-cavity with no preparation of the shell previous to it, in other words, the ephippium may be absent. On the other hand, sometimes the shell is considerably modified, and generally there is a deposit of dark pigment in the upper part of the shell. The males are very rare and until recently few were known. The diligence of Kurz has added a great many, and we now have a fair idea of the sexual variations. These consist usually in a narrower body and shorter beak, in a strong hook of chitin on the first foot and certain modifications of the post-abdomen. The hook mentioned is simply an enlargement of one of the terminal bristles of the foot, and serves to fasten the animal to the shell of the female. In one American species of Pleuroxus we find an approach to this structure in the female—an interesting example of inheritance of sexual peculiarities across the sexes. The alterations in the form of the post-abdomen consist in a narrowing or excavation of that organ to permit its introduction into the brood-cavity, and in some forms (Chydorus) this change can only be understood by observing the form of the shell of the female about to produce winter eggs. In general, as in other Cladocera, males are found only at the period when the females are sexually perfect. The ordinary method of reproduction is by virgin-bearing or parthenogenesis. In some cases it would seem from Weismann's ob servations that the sexual method occurs only incidentally. The orifice of the male organs is between, or anterior to, the terminal claws of the post-abdomen (Eurycercus alone excepted). The males are usually but not always smaller. Plate E gives views of typical Lynceidæ. Fig. 1 is particularly instructive, for in it the details which can be usually made out in the living object are represented. The following points may be especially noticed. The large size of the pigment fleck, the large antennules (A^1), the keel of the labrum (Lb.), the peculiar modification of the first pair of feet to assist the maxillæ (not shown) which are exceedingly small, the largely developed anal gland (A. g.), the form and muscular mechanism of the abdomen, which, however, is better illustrated by fig. 10 of the same plate. Fig. 1 contains an embryo seen from the side with the partially developed limb. Fig. 3 shows the appearance of a different embryo from below and in an earlier stage. Fig. 2 illustrates the relation of the brain to the eye and the very small optic ganglion. Fig. 9 of plate G gives details of the feet in another species, and the modifications seen in the male of the same species are sufficiently shown in fig. 1 of the same plate, which also well illustrates the various sculpture of the shell displayed by this group. Figures 4 and 9 of plate F show curious modifications of the post-abdomen of the male, and fig. 7 exhibits the structural peculiarity of sexually perfect females which is correlated with it or, perhaps we may say, occasions it.

SUB-FAMILY 1.—EURYCERCINÆ.

A single species constitutes the sub-family, and it will be necessary to point out only those points which are distinctive.

The Eurycercinæ differ from the true Lynceidæ and approach the Lyncodaphnidæ in having the digestive tract not coiled, with two cæca in front and the anus at the end of the post-abdomen. Many eggs are produced at once. The male opening is at the base of the abdomen, as in Sididæ. The general habitus is, however, lynceid. The males appear in autumn or when, by the gradual drying up of the water or other causes, the continued existence of the animals is threatened.

I. GENUS EURYCERCUS, Baird.

Characters of the sub-family.

Eurycercus lamellatus, O. F. Mueller.

(Plate H. Figs. 5–6.)

Lynceus lamellatus, MUELLER, EDWARDS, KOCH, ZADDACH, LIEVIN, LEYDIG. ZENKER
Eurycercus lamellatus, BAIRD, LILLJEBORG, SCHOEDLER, P. E. MUELLER, KURZ, BIRGE, HERRICK.
Eurycercus laticaudatus, FISCHER, SCHOEDLER.

A gigantic lynceid, reaching the dimension of 3 mm. The figure of the male given will sufficiently illustrate the general form. The abdomen is broad and armed behind with a dense row of saw-teeth. The eye is larger than the rather small pigment fleck, and the intestine is bent upon itself but not coiled. The last foot is found in few other Lynceidæ. Acroperus has the same, and Pleuroxus unidens also has a rudimentary sixth foot.

SUB-FAMILY II.—LYNCEINÆ.

Intestine coiled; anus near the end of the post-abdomen; opening of vas deferens nearly terminal. There are no anterior cæca but usually a single anal diverticle of the intestine. Rarely or never more than two embryos produced at once.

SERIES A.

Head or dorsal line keeled or ridged; abdomen long; shell marked with diagonal striæ. This section is proposed for the old genera Camptocercus, Acroperus and Alonopsis, which seem to form a natural group though passing directly into Alona.

II.—GENUS CAMPTOCERCUS (>*Camptocercus*, Baird).

This easily recognizable genus contains two groups, each with several nominal species, which are distinguished mainly by the width of the post-abdomen. In both the shell is elongated, more or less quadrangular, longitudinally striate, armed behind with one to four minute teeth. The head and back are keeled and the former strongly arched. The antennules rarely extend beyond the beak and are commonly curved laterally. The eye is proportionately small. The post-abdomen is long and furnished with a lateral row of scales. The terminal claws have a single basal spine and are serrate. There is an ephippium, and the male opening is in front of the terminal claws.

SUB-GENUS 1.—ACROPERUS, Baird.

Post-abdomen broad, margins parallel; anal teeth very minute lateral scales large and usurping their place. Antennæ with eight setæ $(\frac{300}{311})$. Three species are described, one of which is very abundant in Minnesota.

Sp. 1. Acroperus leucocephalus, Koch.

(Plate E, Fig. 5. Plate I, Fig. 9.)

Lynceus leucocephalus, KOCH, FISCHER.
Acroperus harpæ, BAIRD.
Acroperus leucocephalus, SCHOEDLER, P. E. MUELLER, KURZ.
Acroperus sp., HERRICK.
Acroperus striatus, JURINE, M. EDWARDS, LIÉVIN, LILLJEBORG, LEYDIG, etc., seems to belong here, but I am able to add nothing to the elucidation of the puzzle.

Body rounded above, angled behind; head moderately arched and carinated. Lower margin of the shell pectinate, terminating in two teeth. The antennæ are long and when reflexed the setæ reach nearly to the posterior margin of the shell. The posterior angle is not always as prominent as shown in fig. 5.

Sp. 2. Acroperus angustatus, Sars.

(Plate I. Fig. 10.)

Acroperus angustatus, P. E. MUELLER, KURZ.

This species is distinguished from the former by the head, which is higher and very strongly arched. The dorsal contour is nearly straight. The antennæ are shorter. The form of the post-abdomen of the male is less different from that of the female than in the above. The length of both species is about 0.7 mm.

The American form figured in fig. 5 of plate E differs from both the above slightly. The head is carinated and incurved almost as in C. angustatus; the antennæ fall a little short of reaching the posterior margin of the too low and oblong shell; there is an obvious depression between the head and body. However, in the main there is close agreement with C. leucocephalus, to which it has been previously referred. There is always a rudiment of an additional pair of feet.

A. cavirostris, P. E. Mueller, is not known in the female sex. The male has a twisted caudal claw.

SUB-GENUS 2.—CAMPTOCERCUS, Baird.

Although the general form is similar to the last section, the body is usually longer; the post-abdomen narrows toward the end; the anal teeth exceed the lateral row; the antennæ have usually but seven setae $(\frac{300}{310})$.

The species enumerated are so closely related as almost to baffle definition.

KEY TO THE SUB-GENUS CAMPTOCERCUS (verus).

Beak pointed.
- (a) Head depressed.
  - I. Pigment fleck larger than the eye.
    - 1. *C. biserratus*, SCHOEDLER.
  - II. Pigment fleck smaller than the eye.
    - 2. *C. macrurus*, O. F. MUELLER.
- (b) Head directed forward.
    - 3. *C. rectirostris*, SCHOEDLER.

Beak truncate below.
- 4. *C. latirostris*, KURZ.

Beak cleft below or with a forward projection.

(a) Antennules shorter than the beak.

5. *C. lilljeborgii*, SCHOEDLER.

(b) Antennules longer than the beak.

6. *C. rotundus*, HERRICK.

Sp. 1. **Camptocercus biserratus**, Schoedler.

(Plate I. Fig. 4.)

Is very nearly related to the next, from which it is distinguished chiefly by the fact that the pigment fleck is larger than the eye. Schoedler overlooked the fact that in C. macrurus there is a lateral line of scales on the abdomen, and relied upon that character to distinguish this form. (Schoedler says that the pigment fleck in C. macrurus is smaller than the eye, P. E. Mueller says they are nearly equal, while in our specimens they are much smaller or nearly equal.) If much variability is found, Schoedler's species seems to rest on a slender basis. The basal spine of the claw, however, seems to be peculiar in sitting on a distinct prominence.

Sp. 2. **Camptocercus macrurus**, Mueller.

(Plate E. Fig. 10.)

Lynceus macrurus, LILLJEBORG, SCHOEDLER, P. E. MUELLER, KURZ, BIRGE, HERRICK.

This universally distributed species occurs in our larger bodies of water and is not rare, though hardly abundant.

The body is long and nearly rectangular; the head strongly arched and keeled. The keel of the head is extended down the whole dorsal line. The dorsal line is moderately curved, while the shell is but slightly excavated below. The head extends into a blunt beak looking downward; the direction of the head is somewhat variable (from vertical to an angle of about 30°). The eye is much larger than the pigment fleck; the antennules are shorter than the beak, and have one elongated terminal seta. The post-abdomen is very long and has numerous anal teeth as well as a lateral row of scales. The basal spine of the claws is large and serrate, the claw itself being nearly straight and armed with an increasing series of spines to beyond the middle. The lateral scales of the post-abdomen are inconspicuous. The shell gland is long. The antennules reach to almost the end of the beak, are curved and bear a lateral flagellum. The first foot of the female has a sort of hook (branchial sac?). The labrum is armed with teeth on the posterior face of the triangular process. The intestine is very strongly, almost twice coiled. The lower margins of the valves are feebly spined for three-fourths their length, and armed with from one to four teeth at the angle. Length 0.8 mm. to 1.0 mm.

Sp. 3. **Camptocercus rectirostris**, Schoedler.

(Plate I. Figs. 1—3.)

Camptocercus rectirostris, SCHOEDLER, P. E. MUELLER, KURZ.

Distinguished from the above, which it closely resembles, by the form of the head, which is less rounded and directed anteriorly. It hardly exceeds half the hight of the body. The beak is sharp. I am not sure that Weismann's figures (l. c., plate XI, figures 13 and 14) really belong to this species, for the drawing of the post-abdomen does not agree with that of P. E. Mueller fully. Outline copies of the former are given in plate I, figs. 1 and 2. The male has a hook upon the first foot. Not yet recognized in America.

Sp. 4. **Camptocercus latirostris**, Kurz.

(Plate I. Figs. 5—6.)

C. lilljeborgii, P. E. MUELLER (?).

Closely allied to the next, but distinguished by the position of the head, which is a little less depressed, and, especially, by the truncate beak. The dorsal margin is convex and crested; the lower outline is also convex. The claws are toothed more as in C. macrurus than the following. The basal spine springs from the claw itself and not from the post-abdomen as in the next. Length 0.9 mm. to 1.0 mm.

Sp. 5. **Camptocercus lilljeborgii**, Schoedler.

(Plate I. Figs. 7—8.)

Head depressed, rounded in front: beak divided at the end by the extension of the fornices. The terminal claws are pectinate for their entire length, and the basal spine is seated on the end of the post-abdomen. This species, in the main, closely resembles C. macrurus.

Sp. 6. **Camptocercus rotundus**, Herrick.

The second of the two species found in America is this short, strongly carinated form, which is known from a single gathering. It differs from all the above species, with which it agrees pretty well in shape, by its more compact form; high dorsal keel (which extends the entire length of the body); the long antennules, which extend far below the beak; and the somewhat pointed beak. The head is much as in the last, but it is not certain that the beak is cleft, although it has a peculiar form (not indicated in the figure) near the end. The length is 0.7 mm. The terminal setæ of the antennules are very unequal; but in most points, as in the armature of the post-abdomen, the details resemble C. macrurus.

III.—GENUS ALONOPSIS, Sars.

This curious genus includes three species of small lynceids, which exhibit a combination of characters. The form of the beak and head is like that of Pleuroxus, which the form and sculpture of the shell otherwise resembles. The back is extended more or less in a knife-like ridge above, thus resembling Acroperus, a resemblance hightened by the excavated lower margin. The form of the post-abdomen approaches that of Acroperus, but in that genus it is of about equal width throughout and in this it rapidly narrows. The internal organs and feet are of the typical lynceid form, while the antennæ are as in Pleuroxus.

The type of the genus, A. elongata, is apparently much closer to Acroperus than the two species which have been identified in America.

Shell sub-rectangular, high, produced into a ridge above; lower margin convex anteriorly, concave behind; beak rather long; antennules slender; antennæ with eight setæ; abdomen long, narrowed toward end, incised at the extremity; claw rather large, with median spines and a basal thorn; third foot with a long bristle. Male smaller, without the carina above; orifice of sexual organs in front of the claw, which is removed from the anterior margin. The young are more elongate and (sometimes) have hexagonal reticulations instead of the usual strong diagonal striæ. Motion slow.

Sp. 1. **Alonopsis elongata**, Sars.

Lynceus macrurus, LIEVIN.
Lynceus macrurus, ZENKER, LEYDIG.
Alona elongata, SARS.
Acroperus intermedius, SCHOEDLER.
Alonopsis elongata, P. E. MUELLER.

The shell is wide, the upper margin forming an even curve, manifestly angled behind; ventral margin nearly straight, ciliated throughout, with a single tooth behind. Fornices large; head narrow, not carinate. Post-abdomen compressed, truncate at the end, armed with a series of marginal spines and of lateral scales; caudal claws large, with a single spine at the base and two median spines followed by a series of minute setæ.

This form I have never seen, and it seems somewhat doubtful that the following really belong with it.

Sp. 2. Alonopsis latissima, Kurz.

(Plate E, Fig. 8. Plate G, Figs. 1 and 9.)

Body very high, compressed, with a high dorsal keel or ridge; the upper outline strongly and evenly arched, terminating behind in no angle; lower margin almost angled at the anterior third, rounded behind, fringed with long bristles anteriorly, with short ones posteriorly. Head very narrow; beak extremely long; fornices small; antennules nearly as long as the beak, straight and narrow; pigment fleck smaller than the eye. The abdomen is long, somewhat narrowed toward the end, where it is deeply cleft; the terminal claw is furnished with a large and small basal spine, while there is an increasing series of spines extending to the middle.

The elongated spine of the third foot is pectinate and reaches nearly to the posterior margin of the shell. The shell is marked by few strong striæ which are diagonal except anteriorly where are a few parallel to the front margin. The male is small and lacks the crest on the back, while the lower margin is straight; the antennæ are longer than the beak and differ somewhat from those of the female. The first foot has a claw. The post-abdomen lacks the anal teeth. Kurz gives the size as 0.5 mm.

The American form varies between 0.45 mm. and 0.55 mm., and seems to have a higher dorsal keel and longer beak. Kurz speaks of but a single accessory spine on the terminal claws; there is, however, a second very minute spine or cluster of hairs in this as well as the following.

Found in the same gathering with the following near Minneapolis (marshy off-set from Bassett's creek near Oak Lake Addition).*

*NOTE TO ALONOPSIS LATISSIMA. (See Fig. 1, Plate G.) Since writing the above the males of our American form have been found; they are shaped as the females, with a high dorsal keel; the post-abdomen is rounded, with transverse series of small bristles; the claw has a minute median spine, and the *porus genitalis* is anterior and elevated.

Sp. 3. Alonopsis media, Birge.

(Plate E. Fig. 9.)

I give Birge's description verbatim:

"Rostrum prolonged, and shell sharp, somewhat quadrangular in shape, marked by striæ. The dorsal margin is convex, the hinder margin nearly straight. Its lower angle is rounded and without teeth. The lower margin is concave and has long plumose setæ.

The front margin is strongly convex. The post-abdomen is long and slender, resembling that of Camptocercus, and is notched at the distal extremity; it has two rows of fine teeth and some fine scales above them. The terminal claws are long, slender, with a basal spine, a spine in the middle, and are serrated. The antennules are long and slender, but do not reach to the end of the rostrum. They have each a flagellum and sense hairs. The antennæ are small and have eight $\left(\frac{300}{311}\right)$ setæ and two $\left(\frac{100}{100}\right)$ spines. The labrum resembles that of A. leucocephalus, but is slightly prolonged at the apex. The intestine, cæcum and color resemble those of Acroperus. There is a trace of a keel present on the back."

The specimens seen in Minnesota resemble this species very nearly, apparently, but there are some differences. The terminal claw of the post-abdomen has an increasing series of spines to the middle; there seems to be no lateral row of scales beside the anal teeth; the abdomen is rather broad at the base and narrows toward the end. The shell is not square behind. The lower margin has a few long hairs anteriorly which are followed by a series of teeth, and in the concave part a somewhat longer set to a point just before the lower curved angle.

The pigment fleck is nearly or quite as large as the eye. The antennule is shorter than the beak (which is almost as in Pleuroxus hastatus), and has a flagellum about midway; at its base it is narrowed and inserted on a prominence.

The embryo still in the brood sac had a more elongate form and hexagonal reticulations upon the shell, while the antennules were longer than the very long beak, and the pigment fleck was smaller than the eye. Length of female 0.52 mm. The color is darker, and the striæ more numerous, than in A. latissima.

SERIES B.

This section includes forms with (usually) no keel above, or, if keeled, the post-abdomen is not long. The majority are highly arched dorsally, and have comparatively short post-abdomen and pointed beak. The antennæ are usually feeble and the motion slow.

A. Post-abdomen nearly round in outline, armed with very long stout spines, terminal claw with one minute basal spine or none; greatest hight of shell about equal to the posterior margin.

1. Genus *Leydigia*.

B. Greatest hight of shell moderately exceeding that of posterior margin; post-abdomen more or less triangular, armed with bristles; shell marked with hexagonal meshes.

(a) Head nearly horizontal, blunt; post-abdomen prominent in the anal region.

2. Genus *Graptoleberis*.

(b) Head depressed, acute; post-abdomen excised near the anus.
3. Genus *Crepidocercus*.

C. Post-abdomen more or less quadrangular, armed with one or two rows of small teeth on either side behind; terminal claws with one or two basal spines; hight of posterior shell margin usually less than the greatest hight of shell.
4. Genus *Lynceus*.

D. Greatest hight of shell little less than that of posterior shell margin; post-abdomen terete; terminal claws very minute.
5. Genus *Phrixura*.

E. Greatest hight of shell more than double that of posterior margin.
(a) Eye and first foot normal.
6. Genus *Chydorus*.
(b) First foot with a claw which extends beyond the shell.
7. Genus *Anchistropus*.
(c) Eye absent, only pigment fleck used for vision.
8. Genus *Monospilus*.

IV.—GENUS LEYDIGIA, Kurz.

In this genus, both the known species of which are found in America, the posterior part of the shell and body is emphasized at the expense of the anterior. The curved posterior margin is equal to the greatest hight of the shell. The head and anterior part of the body are of the form characteristic of Alona; indeed, the whole body is in plan like Alona, but in the back part the organs are all enlarged. The general form of the body and abdomen recalls Ilyocryptus; the post-abdomen, in particular is very like that genus. The last two pairs of feet are much enlarged. The shell is usually irregularly marked with longitudinal striæ; the lower margin is covered with long spine-like setæ. The post-abdomen is armed with several sets of long spines and aggregations of bristles and small spines; it is almost round and enormously enlarged. The intestine is coiled and expanded at the end, but the anal cæcum is rudimentary. The antennæ are heavily spined and have eight setæ; the labrum is more or less hairy. The male has a strong hook on the first foot, and between the terminal claws of the abdomen is a peculiar intromittent organ.

Sp. 1. **Leydigia quadrangularis**, Leydig.

(Plate H. Fig. 4.)

Lynceus quadrangularis, LEYDIG, FRIC.
Alona leydigii, SCHOEDLER, P. E. MUELLER.
Leydigia quadrangularis, KURZ.

The shell is comparable to that of Alona quadrangularis, but higher behind; the markings are not very distinct; shell transparent. The head is very small; the eye smaller than or of about the size of the pigment fleck. The post-abdomen is very broad, the posterior margin nearly the segment of a circle, armed with numerous very long unequal spines which extend only about half the hight, being replaced by short close hairs; the anal opening is very high; the terminal claws are long, straightish, and have a small thorn near the base.

The males are smaller than the females, and the abdomen is less broad; the antennules are longer than the beak and furnished with a flagellum. The sexual period occurs in September or irregularly. This species has only been encountered once, during September, in Poplar river, Cullman county, Alabama.

Sp. 2. **Leydigia acanthocercoides**, Fischer.

Lynceus acanthocercoides. FISCHER, LEYDIG.
Eurycercus acanthocercoides, SCHOEDLER.
Alona acanthocercoides, P. E. MUELLER.
Leydigia acanthocercoides, KURZ.
Leydigia quadrangularis, HERRICK.

This species, reported in a previous paper, is, as was said, nearest like L. acanthocercoides; and I am now able to verify the very inconspicuous differences upon which the two are separated. Our specimens of the L. quadrangularis have the pigment fleck fully as large as the eye, Kurz to the contrary notwithstanding, and the claw of the post-abdomen is present, while in the present species the pigment fleck is much larger and furnished with lenses; the spine of the claw is wanting; the labrum is densely hairy; the abdomen is narrower, and the shell higher. The shell is very obviously striped in the posterior portion. The anus is higher than in the previous species. In other respects the two seem alike.

V.—GENUS GRAPTOLEBERIS, Sars.

A genus containing two closely allied species, having some affinities with Alonella. The shell is entirely reticulated, and there is a sort of crest along the back; while, on the other hand, the head is flattened and rounded in front. There can hardly be said to be a beak. Seen from above, the animal resembles some species of Alonella, but the head is larger proportionally and more horizontal. The lower posterior angle is spined. The antennæ have seven setæ and are very long, in this respect resembling Camptocercus. The dorsal contour is not greatly arched. The post-abdomen has short claws and anal bristles, but no teeth.

Sp. 1. Graptoleberis testudinaria, Fischer.

Lynceus testudinarius, LEYDIG, LILLJEBORG.
Lynceus reticulatus, FRIC.
Alona testudinaria, SCHOEDLER.
Graptoleberis testudinaria, KURZ.
Graptoleberis inermis, BIRGE.

Form trapezoidal; lower margin straight, armed behind with two teeth, thickly beset with long hairs in front; the dorsal margin is not greatly elevated, rounded at the posterior angle, forming a slight "hump" where it unites with the head shield. The head and shell are reticulated with hexagonal or quadrangular markings. The shell gapes below and rises to a sharp ridge above. The antennæ have long rami, the antennules being hardly longer than the fornices. The eye is large; the pigment fleck is small. The post-abdomen is narrowed toward the end, rounded in front; the terminal claws are small and have two basal teeth. The dorsal margin of the post-abdomen is covered with tufts of hairs. The winter eggs have no ephippium. Length 0.55 mm. to 0.7 mm. The male is smaller and has a lower dorsal keel; the post-abdomen is excavated behind.

The only differences between the Minnesota specimens and the typical European form seemed to be the absence of the very minute spines on the front of the terminal claws. The eye and pigment fleck are of about the proportions figured by Kurz. Birge's figure of the post-abdomen does not agree with his description fully. Our Minnesota specimens have an obvious but not high keel.

Sp. 2. Graptoleberis reticulata, Baird.

Alona reticulata, BAIRD, P. E. MUELLER.
Lynceus reticulatus, LILLJEBORG, LEYDIG.
Alona esocirostris, SCHOEDLER.
Graptoleberis reticulata, SARS, KURZ.

Shell almost rectangular, reticulate, ventral margin straight, ciliate anteriorly, with two teeth behind. Pigment fleck smaller than the eye. Post-abdomen short, narrowed towards the end, dorsally covered with clusters of spines; caudal claws with a minute tooth at the base. Length 0.4 mm. to 0.5 mm.

The pigment fleck is nearer the end of the beak than the eye, and is smaller than in the previous species, but, on the whole, there is perhaps, too great similarity.

VI.—GENUS CREPIDOCERCUS, Birge.

The characters of this group place it rather near Alonella or between that and Pleuroxus. Form sub-quadrate with rounded angles; dorsal line uniformly arched, terminating in a sharp angle behind; lower margin convex, armed behind with a single spine as in Pleuroxus unidens, and along the entire length with loose setæ. Beak of moderate length, acute. Post-abdomen deeply incised in the anal region; lower posterior margin straight, rounded at the apex; ventral margin straight or concave; claws with a single basal spine and a few teeth. The post-abdomen is shoe-shaped and armed with transverse rows of setæ.

The antennæ are large, having eight setæ and the usual spines. Shell smooth or reticulate.

Sp. 1. **Crepidocercus setiger**, Birge.

(Plate F. Fig. 13.)

Length 0.4 mm. to 0.5 mm. Minnesota specimens measured 0 5 mm. This, the only species of the genus, is but rarely encountered, and is so peculiar as to be easily recognized when seen. Alona intermedia has a post-abdomen with clusters of bristles, but in Crepidocercus the post-abdomen is more as in species of Graptoleberis than any other genus. The markings upon the shell are very indistinct.

VII.—GENUS LYNCEUS, O. F. Mueller.

The perplexing inter-relations between the three genera Alona, Alonella and Pleuroxus give rise to the utmost confusion. No two authors are agreed as to their respective limits, and the points given by Kurz, who has carefully gone over the ground, are obviously insufficient. Although there may be practical benefits to be derived from the continuance of the nomenclature in use for groups which in the general view can be distinguished, the value from a theoretical standpoint is reduced to a minimum.

The genus Camptocercus (including here Acroperus, which differs solely in the form of the abdomen, as a sub-genus) passes through Alonopsis into the group represented by Alona. Leydigia, although very near such forms as Alona quadrangulata, may be conveniently distinguished as a transition to species like Ilyocryptus.

Phrixura, Graptoleberis and Crepidocercus, each containing few species which can be readily recognized, fill a place in the system; but it is practically impossible to distinguish Alona from Pleuroxus without instituting the very indefinite genus Alonella to contain a variety of small intermediate forms. Percantha, Rhypophilus, Harporhynchus and Pleuroxus seem to be pretty generally regarded as constituting a single group which may be recognized by the long rostrum, high shell and greater development of the antenna bristles. Alona, on the other hand, with its broader fornices, shorter beak, fairly developed antennæ, and more rectangular shell, is, perhaps, the pivotal point of the group. According to this view, then, the old name *Lynceus* is revived for the aggregate; and the other names are retained, in part, as titles of largely conventional groups or sub-genera, thus:

GENUS LYNCEUS.

- Sub-genus ALONA.
    - Section A. *Alona vera.*
    - Section B. *Alonella.*
- Sub-genus PLEUROXUS.
    - Section A. *Pleuroxus verus.*
    - Section B. *Leptorhynchus.*[1]

Characters of Percantha and Rhypophilus are combined in the species P. procurvus, Birge, so that one must be dropped or new diagnoses formulated. I am not sure that the same species is not at first Pleuroxus verus[2] and only later assumes the form known as Rhypophilus. So with Percantha the amount of serrature of the posterior margin is in part a question of age.

SUB-GENUS ALONA.

This group contains two sections which resemble each other in form and, in general, in detail; but it is exceedingly difficult to formulate a diagnosis that shall strictly limit it. The form is generally sub-quadrangular with rounded corners; the terminal claw is armed with but a single spine at the base; the beak is rather short; and the prevailing marking consists of longitudinal lines.

Section A. *Alona* (*vera*). Baird.

This genus contains a large number of minute animals which are widely distributed.

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[1] Instead of Harporhynchus, a name preoccupied in zoology.

[2] Embryos of P. procurvus have the part which is to be curved forward attenuated before leaving the brood-cavity, however.

The authors who have done the most to elucidate this genus are Schoedler, P. E. Mueller, and Kurz. Birge has contributed most largely, thus far, to the knowledge of American species, which are, for the most part, identical or very close to the European. No other genus is so difficult among the Lynceidæ, for the most minute differences are relied upon to distinguish species. The species of this genus are not greatly altered by the production of the winter eggs. The males are frequently but little smaller than the opposite sex, and are recognized by the altered form of the post-abdomen and the presence of a hook on the first foot. The form is more perfectly rectangular than in the next section; the shell is only exceptionally reticulated and very rarely tuberculate, occasionally smooth. The lower angle of the shell is not armed with spines, but is generally rounded. There is only one basal spine upon the claw of the post-abdomen, which usually bears a row of scales beside the anal spines. The antennæ have eight setæ. The claw of the male post-abdomen is removed from the lower angle.

About twenty species are known, all of which that seemed recognizably defined have been included in the following key, which is believed to be more nearly natural in its arrangement than that of Kurz, which would separate the European and American representatives of the A. parvula group. Many more forms remain to reward the labor of American students. Those mentioned from Minnesota could probably all be found by a few days search in one locality.

KEY TO SECTION A, ALONA.

A. Shell reticulate.
  (a) **Reticulations horizontal.**
    1. *A. guttata*, **Sars.**
  (b) **Reticulations oblique.**
    2. *A. angulata*, **Birge.**

B. Shell lined, smooth or tuberculate.
  (a) **Over 0.5 mm. in length.**
      I. **Shell densely striate.**
    3. *A. sanguinea*, **P. E. Mueller.**
      II. **Shell normally, evidently striate.**
     * **Post-abdomen narrowed at the end.**
     † **Armed with elongate teeth below.**
    4. *A. tenuicaudis*, **Sars.**
     †† **Teeth of post-abdomen nearly equal.**
    5. *A. lineata*, **Fischer. (Shell arched.)**

6. *A. modesta*, Herrick. (Shell straight above.)
** Post-abdomen not narrowed.
† Antennæ with seven setæ.
(?) 7. *A. costata*, Sars.
†† Antennæ with eight setæ.
8. *A. quadrangularis*, Mueller.
III. Shell faintly, irregularly striped; eye of same size as pigment fleck.
9. *A. oblonga*, P. E. Mueller.
IV. Shell smooth.
10. *A. affinis*, Leydig.
(b) Under 0.5 mm. in length.
I. Post-abdomen armed with a row of hairs terminating in large teeth.
11. *A. dentata*, P. E. Mueller.
II. (One or) two rows of teeth present.
* Shell densely and evenly striate.
12. *A. elegans*, Kurz.
** Shell not densely lined.
† Shell smooth or lined longitudinally.
‡ Teeth of post-abdomen unequal, the lower ones enlarged.
13. *A. porrecta*, Birge.
‡‡ Teeth nearly equal.
§ Form elongated; abdomen with a lateral line of spiny scales.
14. *A. spinifera*, Scheedler.
§§ Form squarish; abdomen with a lateral line of simple spines or bristles, or neither.
15. *A. parvula*, Kurz.
16. *A. glacialis*, Birge.
‡‡‡ Clusters of bristles, not spines, on the posterior edge of the post-abdomen.
17. *A. intermedia*, Sars.
†† Shell smooth or tuberculate.
18, 19. *A. tuberculata*, Kurz, Herrick.

Sp. 1. Alona guttata, Sars.

A small species of sub-quadrangular form. The beak is very short; the eye small, but larger than the minute pigment fleck. The shell is short, with a rounded posterior angle and marked by hexagonal or rectangular meshes running about parallel with the lower margin. The post-abdomen is of moderate size, rounded at the apex, with a series of stout teeth behind; the terminal claw has a minute basal spine. P. E. Mueller, in Danmark's Cladocera, confused this with A. intermedia, which he described under this. The post-abdomen in that species is larger, less rounded behind, and armed with clusters of spines instead of teeth. The length is about 0.3 mm. in both.

Sp. 2. **Alona angulata,** Birge.

Dorsal margin considerably arched, terminating in a more or less obvious angle at the hinder corner; the hinder edge is convex, as is also the front margin; the ventral margin bears plumose setæ. Beak pointed, extending nearly to level of ventral margin of the valves. Fornices broad. Shell obviously striated diagonally and less obviously marked by cross lines. Post-abdomen broad, truncate; about twelve anal teeth, with a series of scales and hairs back of them. The pigment fleck is much smaller than the eye. Male smaller; beak shorter; post-abdomen with a lateral row of hairs; anterior feet hooked; sculpture less distinct. [Birge.] Length of female 0.4 mm; male 0.35 mm.

Sp. 3. **Alona sanguinea,** P. E. Mueller.

(Plate I. Fig. 20.)

Body nearly rectangular; ventral margin nearly straight, with short setæ; posterior angle rounded, unarmed. Beak short; pigment fleck much larger than the eye. Post-abdomen large, the end truncate, broadened; posterior margin rounded, with a series of spines and a lateral row of scales; terminal claw with a small spine. The shell is ornamented with fine, close, longitudinal striations. Length 0.9 mm. Alona elegans is very near to this and should have followed. In August, 1878, I took an Alona marked as in A. sanguinea and agreeing with Mueller's description in all points which can be verified in the drawing. The small size of the eye is remarkable for so large an animal. I have never again seen this species; it seems to be very rare here and in Europe.

Sp. 4. **Alona tenuicaudis,** Sars.

(Plate I. Fig. 11.)

Alona tenuicaudis, SARS, P. E MUELLER, KURZ.
Alona camptocercoides, SCHOEDLER.

Form nearly rectangular; ventral margin rounded, with long setæ, posterior angle rounded. Beak short, pigment fleck smaller than the eye. Post-abdomen with sides parallel, long, incised below; lower angle armed with about six strong teeth, remainder of the series small; a lateral line of scales present; claws with a strong basal spine. The shell is striate with longitudinal lines. Length 0.5 mm.

One of the most easily recognized species; not identified in America.

Sp. 5. Alona lineata, Fischer.

Lynceus lineatus, FISCHER, LEYDIG.
Alona lineata. SCHOEDLER, P. E. MUELLER, KURZ.
Alona rectangularis, SARS.

The upper margin is rounded, the lower one somewhat sinuate, with setæ of moderate length. The beak is tolerably long, reaching nearly to the level of the lower margin of the shell; the pigment fleck is less than the eye, to which it is much nearer than to the end of the beak. Post-abdomen short, broad and tapering toward the end, truncate, armed with about ten large teeth; caudal claws with a small basal tooth. Shell marked with distinct lines running horizontally. The ephippial females are recognized by a deep color and the greater elevation of the back. Length 0.5 mm., 0.6 mm. The male has a weak hook on the first foot, and the post-abdomen is narrowed toward the end; the terminal claw has no spine.

The Minnesota representative of this widely distributed species differs in some respects. The lower margin is nearly straight and rather sparsely hairy; the beak is blunt, but, on account of the spreading of the extremely wide fornices, does not appear so except under pressure.

The beak reaches nearly to the lower shell margin. The antennules are narrow, one or more of the setæ being elongated. The dorsal margin is either nearly straight or strongly arched behind; in either case the greatest hight of the shell is back of the middle. The pigment fleck is large. The post-abdomen is just as in A. lineata, but the lateral row seems to be of spines rather than fringed scales. The shell is marked by rather evident or indistinct lines. The form agrees pretty well with Schoedler's figure, except that the posterior shell margin is much higher. The antennæ have eight setæ, but the last one is very weak. The terminal setæ seem sometimes to be spined, as figured by Schoedler, but in some specimens they are perfectly smooth. There is a circlet of spines on the second joint of the setose ramus. There is a hair on the inner aspect of the protuberance of the labrum. The eye is somewhat nearer the pigment fleck than is the end of the beak. If it is desirable to apply a new name to a form at least so near the European A. lineata, it may bear the name first given it in my note-book.

? Sp. 6. Alona modesta. (Sp. n.)

(Plate H, Fig. 3; and Plate Q, Fig. 4.)

The length varies between 0.41 mm. and 0.55 mm. The smaller forms have the back most rounded, while a specimen 0.55 mm. long will appear very like A. quadrangularis. Males are elongate; hook of first foot strong, accompanied by a heavy growth of small spines; terminal claw of abdomen with a minute spine.

? Sp. 7. Alona costata, Sars.

Founded practically upon the absence of the eighth seta of the antennæ. The description given by Sars will not render it recognizable so that there is no occasion to repeat it here. In all the species of this section the eighth seta is small and may be absent.

Sp. 8. Alona quadrangularis, Mueller.

(Plate E. Figs. 1—2.)

Alona sulcata, SCHOEDLER.
Alona quadrangularis, P. E. MUELLER, KURZ, HERRICK. The further synonomy of the species may well be doubtful, for there are species so closely allied as to render a strict determination difficult.
Lynceus quadrangularis, O. F. MUELLER, is the name employed, and is thought to be identical with the Alona quadrangularis of Baird.

Shell quadrangular, highest behind; lower margin straight; posterior margin curved; lower angle rounded, striped with rather evident lines which are parallel and straight. The beak is quite long; the pigment fleck is smaller than the eye. The post-abdomen is broadest near the end, where it is strongly rounded; the numerous anal spines are strong and emarginated, supported by a lateral series of scales; the terminal claw and its basal spine (in American forms) are denticulate (Kurz says smooth in European specimens). The feet are of the typical Alona form (see plate E, fig. 1). The shell gland is rather conspicuous; no true ephippium. The abdomen of the male lacks the spines, but is otherwise similar. Length 0.6 mm. to 0.7 mm. Less abundant in Minnesota than the next. Both this and the following species were recognized in 1878, but were thought to be the same species. (See *Microscopic Entomostraca*, p. 109.)

Sp. 9. Alona oblonga, P. E. Mueller.

Alona oblonga, KURZ, BIRGE.
Alona quadrangularis, LILLJEBORG.

Differs from A. quadrangularis in the following points:—the greatest hight of the shell is anterior to the middle; the lines are less evident, and all confined to the lower part of the shell, while the centre of the valves is marked with very minute striæ; the pigment fleck equals the eye; and the post-abdomen is of about the same width throughout and hardly as round below. This and the preceeding species have a well marked keel on the process of the labrum. The size is greater, this being one of the largest and most abundant, as well as one of the most striking species. It, perhaps, should rank as a well marked and permanent variety of the above. Length 0.9—1.0 mm. The abdomen of the male is narrowed at the end and lacks the teeth. Lakes about Minneapolis.

(A small form of A. quadrangularis in lake Calhoun had the eye and pigment fleck equal and the terminal claw smooth.)

Sp. 10. **Alona affinis**, Leydig.

(Plate F. Fig. 14.)

Lynceus affinis, LEYDIG.
Alona affinis, SCHOEDLER.

Form sub-quadrangular; hight about once and one-half in length; the dorsal outline forming a regular and low curve from end of head to upper posterior margin; lower outline very slightly sinuate, anterior one not at all: posterior angles rounded; head nearly horizontal; eye of moderate size; pigment fleck considerably smaller; antennules rather large, with unequal sensory hairs at the end, one spine just above the end in front and a bunch of minute hairs near the base behind; antennæ comparatively large, basal joint spiny. outer ramus with three setæ, two of which have thorns at their middle, also a terminal spine; inner branch with two of the terminal setæ thorned and the upper lateral seta reduced. The post-abdomen is very broad and short, expanded below and rounded at the end; the terminal claws are straightish, denticulate, and the spine at the base is also dentate; there is a series of heavy spines on the upper margin of the post-abdomen, accompanied by a series of scales on the side. The shell is unornamented and fringed below with short bristles. Length 0.9 mm., or more. This fine species is recognized by its smooth shell, the horizontal position of the head, and the form of the post-abdomen; it belongs among the largest of the genus. Lakes near Minneapolis, not rare.

Birge quotes A. spinifera from Wisconsin. In all probability that species is the younger stage of the above.

Sp. 11. **Alona dentata,** P. E. Mueller.

(Plate I. Figs. 12—13.)

Form sub-rectangular, somewhat arched above, obscurely longitudinally striated; lower angle obtuse, margined below with short setæ. Post-abdomen small, slender, armed with a lateral line of scales and two strong teeth at the lower angle; claw with a minute basal spine. The form of the post-abdomen is identical with "Harporhynchus" falcatus, Sars, which this species also resembles in having the pigment fleck larger than the eye, and in general form and the character of the striation. The beak, however, is very short. In size P. E. Mueller says it is among the smallest of the genus.

Sp. 12 **Alona elegans,** Kurz.

(Plate I. Fig. 14.)

Form rectangular; back slightly elevated, posterior margin high, lower margin straight. Shell covered with minute striations springing from the region of the attachment of the head shield. Head rather large, pigment fleck smaller than the eye. The antennæ have eight setæ and a circlet of spines on the second joint of the inner ramus, and a single thorn on its first joint. The post-abdomen is short and broad, rounded at the end, and is armed with about ten anal teeth and a lateral row of scales. Length 0.4 mm.-0.5 mm.

Sp. 13. **Alona porrecta,** Birge.

Sub-rectangular ; ventral line nearly straight; valves marked by longitudinal striæ; beak short. Post-abdomen truncate, with about twelve teeth, three or four of which at the end are larger, and a row of hairs above the teeth. Male similar. Length 0.34 mm. Distinguishable from the following small species in the armature of the post-abdomen.

Sp. 14. **Alona spinifera,** Schoedler.

If not the young of A. affinis, this little species mimics it very closely. The head is less horizontal and more acute than in that species, otherwise almost identical excepting in size which is about one-third. The sensory setæ of the antennules are said to be nearer equal. Found by Birge in Massachusetts and Wisconsin, but not yet encountered in Minnesota.

Sp. 15. Alona parvula, Kurz.

The body is sub-quadrangular, arched above; ventral margin straight, rounded behind. Shell marked by longitudinal, feeble and irregular lines. The post-abdomen is narrower toward the end, with eight or more teeth; the row of scales is absent; at the end it is sharply truncate and incised; the claws have short basal spines. Hardly to be distinguished from the next.

(18.) Alona parvula, var. tuberculata, Kurz.

Alona tuberculata, KURZ.
Alona verrucosa, LUTZ.

The species described by Kurz in 1874, and more at length by Lutz under a different name in 1878, appears to be simply a tuberculate variety of the above. Observations upon the American representatives of the two forms indicate a close relationship between them. The shell is covered with rows of tubercles (or depressions?) which vary in number greatly.

Sp. 16. Alona glacialis, Birge.

(Plate G. Figs. 2, 3 and 8.)

I do not know how to distinguish this certainly from A. parvula. It, however, seems to have the lower angle of the post-abdomen less squarely truncate and the incision less obvious. Birge says that the abdomen is rounded. I have found specimens which apparently belong here, with the post-abdomen rather sharply angled and deeply incised; there were about fourteen teeth with a row of hairs in front. The form is hardly to be distinguished from another variety which has a shorter post-abdomen, rounded below, and with only about seven or eight teeth and with a smooth shell. This form passes directly into a tuberculate variety, having the post-abdomen similar but the shell covered with numerous rows of tubercles. Sometimes a transition from a lined shell to a tuberculate shell is seen (as in plate G, fig. 14). Alona tuberculata, Kurz, is said to have a truncate and incised post-abdomen with no lateral row of hairs. Birge thinks these identical; if so, our form referred to A. glacialis is identical with A. parvula. There is also a form found with the above in which no markings are visible and the shell is considerably arched; these were, however, nearly all ephippial females or approaching that period.

(19.) Alona glacialis (?), var. tuberculata, (Var. n.)

(Plate G. Figs. 4—7 and 14),

will, then, be our tuberculated Alona with a lateral row of scales and a series of fine spines along the anus.

Alona glacialis (?), var. lævis, (var. n.)

is the smooth form with higher dorsal margin.

The antennæ of the two last have spines at the end of the rami of the antennæ, a circlet of spines on the outside of the second joint of the setose ramus, and a spine on the basal joint of the other ramus; two of the setæ at the end of the setose ramus have spines at the angles. The males found among the above small forms have the same characters as var. lævis and the abdomen is rounded at the end; the claw is situated in the middle of the lower margin, in front being the opening of the *porus genitalis* and behind a cluster of hairs; the spines are absent, but there is a lateral row of long bristles. A strong hook is found on the first foot. Length 0.3 mm

Sp. 17. Alona intermedia, Sars.

(Plate I. Fig. 15.)

Alona guttata, P. E. MUELLER.

Form sub-rectangular, rounded below; beak short; shell marked by longitudinal lines, which may be broken into indistinct rectangular meshes. Post-abdomen short and wide, rounded at the end, ornamented by clusters of minute spines behind as well as a lateral row of scales. About 0.3 mm. long.

Section B. ALONELLA, Sars.

In this group are included small species with a combination of characters, forming the link between Alona and Pleuroxus. An obvious character is the fact that the shell is usually partly marked by oblique striæ, which run in two directions: first, a set extending forward and upward from the lower posterior angle of the valves; second, a set springing from the anterior and lower angle, running across the others. At the central part where these two series intersect, they each become zigzag; the result is a series of hexagonal markings, which may extend to the middle of the lower margin.

The beak is short and the fornices broad; the shell is more or less rectangular, but somewhat elevated in the middle above.

There are usually but seven setæ on the antennæ, or the eighth is a minute hair; on the ramus having the lateral setæ one of the terminal setæ is frequently reduced. In many cases the whole shell is marked by minute striæ in addition to the proper markings, but this is also found in some species of the true Pleuroxus. Kurz gives, as a character of Alonella, the presence of but a single basal spine to the claw of the post-abdomen; but P. E. Mueller figures two spines on the claws of one of his species (A. exigua), and Schoedler figures eight setæ on the antenna of A. excisa. American specimens of A. excisa and of A. pygmæa both certainly have a very minute eighth seta. There remains, therefore, positively no point which can be relied upon to distinguish these little lynceids from Pleuroxus or Alona. Perhaps, however, these species, as a group, may be recognized by what has already been said. Three species are found in Minnesota.

A. Rostrum long, bent backwards.
   1. *A. rostrata*, Koch.
B. Rostrum short.
      I. Lower posterior angle toothed.
   (a) Shell more or less reticulate.
      * Reticulated areas minutely striate.
   2. *A. pulchella*, Herrick.
   3. *A. excisa*, Fischer.
      ** Reticulated areas smooth.
      † Head depressed.
   4. *A. exigua*, Lilljeborg.
      †† Head horizontal.
   (?) 5. *A. grisea*, Fischer.
   (b) Shell marked by lines running diagonally upward and backward.
   6. *A. pygmæa*, Sars.
      II. Lower posterior angle smooth, shell longitudinally striate.
   7. *A. striata*, Schoedler.

Sp. 1. Alonella rostrata, Koch.

Lynceus rostratus, KOCH, LILLJEBORG, SCHOEDLER.
Alonella rostrata, SARS, KURZ,
Alona rostrata, P. E. MUELLER.

Body long, rapidly narrowed behind; dorsal line strongly arched in front toward the depressed head; the lower margin straight, with 0—3 small teeth at the angle. The fornices are broad, but the beak is sharp; the pigment fleck is but little smaller than the eye, to which it is three times nearer than to the beak. The post-abdomen is long, very much as in A. excisa, but longer. Length 0.4—

0.5 mm. Schoedler says the lower margin is concave and the angle unarmed, a condition not inconsistent with specific identity, as can be seen in many other species. The shell seems to be variably marked, but most conspicuous are the diagonal, curved striæ. Schoedler compares the sculpture to P. exiguus; Kurz, however, leaves the impression that only slight reticulation is present in the female.

The male has the post-abdomen narrowed, ornamented with clusters of hairs behind, and the small claws have no basal spine, while the genital opening is in front of the claws.

Sp. 2. **Alonella pulchella.** (Sp. n.)

(Plate Q. Figs. 1—3.)

A minute form very recently obtained is described under the above name. Although closely allied to A. exigua, this species is more like Graptoleberis than any other member of the genus. It is the smallest of the lynceids, excepting A. pygmæa. The shell is high and rather strongly arched; the posterior margin is short and armed with four teeth below, which point in different directions as in Graptoleberis. The head is short and the antennules long. The pigment fleck is of moderate size, but smaller than the eye. The post-abdomen is short, rounded below, and armed with sharp and small anal teeth, besides which is an inconspicuous row of minute setæ. The claw is very small, and has a single very minute tooth. The shell is marked by reticulations, which below are regular hexagons but above pass into elongated meshes, and finally on the beak and head become longitudinal striations. The areas are lined as in A. excisa. Thus this species combines the form of abdomen of A. exigua with the teeth of Graptoleberis and the markings of A. excisa.

Length hardly 0.27 mm. Motion active. The specimen figured contained a single large ovum. The head may possibly have been somewhat protruded by pressure. Habitat, vicinity of Minneapolis.

Sp. 3. **Alonella excisa,** Fischer.

(Plate E, Fig. 6; and Plate G, Figs. 10. 11.)

Lynceus excisus, FISCHER.
Pleuroxus excisus, SCHOEDLER.
Alonella excisa, KURZ.
? *Pleuroxus insculptus*, BIRGE.

This species is closely allied to Alonella exigua; yet that species shows appreciable differences, (which can hardly be claimed, perhaps, for Pleuroxus insculptus.) The various authors who have written of this lynceid have all laid emphasis upon the sculpture of the shell, almost to the exclusion of other points in the description. Prof. Birge has found a quite different form, apparently, which has the same peculiar markings; and even the common Alona oblonga has a part of the valves covered by minute striations. Schoedler's figure of this species is unrecognizable; but, as identified by Kurz, the species seems undoubtedly the same that is common in shallow pools in Minnesota, during autumn, and probably also in Massachusetts.

The variations to which this species is subject are considerable and may account for the marked disagreement in the accounts of our different authors. Schoedler gives his specimens a length of .20-.25 mm., while Kurz says .35 mm. Birge gives .27 for the length of Pleuroxus insculptus, and our specimens varied in the same gathering between .24 mm. and .40 mm. Schoedler figures three teeth at the lower posterior angle; Kurz says "several (4);" Birge describes one or two, and Minnesota specimens show gradual transitions from an inconspicuous angle to three or perhaps four teeth. These teeth are the extensions of some of the strong ridges or crenulations which mark the shell. P. E. Mueller's figures of the shell and abdomen of P. exigua would apply to our species perfectly, save the absence of minute striations; Kurz's statements with reference to the differences between these two forms seem to agree only in part with those of Schoedler. I must here express my suspicion that the Pleuroxus aculeatus, P. exiguus and P. excisus all belong under this species. I have seen a small form which lacked the fine striations; and there appeared to me to be, at times, a slight indication of a second series of hairs upon the post-abdomen.

The form is oblong, truncate behind, variously arched above, but usually with a rather low, evenly curved dorsal contour; the lower shell margin is either nearly straight or convex in front and concave along the posterior third, and is heavily beset with very long pectinate bristles. The head is moderately depressed, with a very broad, blunt and short beak (in some positions this beak seems acute, but it is an optical delusion); the fornices are very broad, covering the antennules completely; seen from above the head is broad and truncate in front; the eye is larger than the large pigment fleck, which is nearer it than the end of the beak. The antennæ have eight setæ, the last of which is minute; the five-spined ramus has a strong thorn on the end, and the inner terminal seta is reduced. The post-abdomen is rather broad and truncate or somewhat rounded below; its length is very variable, being short in small individuals; its form is subject to concomitant variations. The seven to eleven anal spines extend in a series of minute bristles above the anus. The lower posterior angle of the shell bears one to four teeth; the marking consists of wavy ridges and striæ, producing, by the crossing of two sets springing from the two lower angles, a reticulation covering more of less of the entire shell. The head-shield and the spaces between these markings are densely striated. Color yellowish, often opaque. Length 0.24.-0.40 mm. At times abundant. Birge alone has seen the males; his description agrees with Kurz's account of the male of A. exigua, save that the former speaks of spines, and the latter of thorns, along the post-abdomen.

Sp. 4. **Alonella exigua,** Lilljeborg.

Lynceus exiguus, LILLJEBORG, LEYDIG, FRIC.
Alonella exigua, SARS, KURZ.
Pleuroxus exiguus, SCHOEDLER, P. E. MUELLER.
? *Lynceus aculeatus*, FISCHER.

Aside from the differences in the male sex as above indicated, this form is said to have a convex lower margin, a rounded post-abdomen, and the pigment fleck nearer the end of the beak than the eye, The absence of the fine striation, finally, is the most marked characteristic. Length 0.30-0.33 mm. Not identified in America.

(?) Sp. 5. **Alonella grisea,** Fischer.

This species is included here on the authority of Kurz. The shell may or may not be toothed at the lower corner, and is partly lined and partly reticulate; but the only character which at all separates this species from the above seems to be the position and form of the head, which is said to be blunt and nearly horizontal, as in Camptocercus rectirostris. Is this a transition to Graptoleberis?

Sp. 6. **Alonella pygmæa,** Sars.

(Plate H Fig. 7.)

Alona pygmæa, SARS.
Pleuroxus transversus, SCHOEDLER.
Alona transversa, P. E. MUELLER.
Lynceus nanus, FRIC.
Alonella pygmæa, KURZ.

The form is rotund, much like species of Chydorus in the highly arched dorsal outline; the beak is rather short and depressed; the lower outline of the valves is very convex in front, and barely sinuate behind, where it terminates in a minute spine. The shell is marked, as in no other lynceid, by lines running diagonally backward, and only on the lower part reticulated, if at all.

The post-abdomen is short, broad and rounded below; the claw has a single basal spine. Length 0.20 mm.—0.28 mm. This is the smallest member of the Cladocera. In form it so nearly resembles Chydorus that upon first sight the writer took it for a member of that genus. Our one specimen measured 0.25 mm. The shell is marked by plications rather than striæ, which arch over the back.

Sp. 7. **Alonella straiat,** Schoedler.

This species is said to resemble A. exigua in habit and sculpture of shell; the form is quadrangular and not greatly elevated in the middle; the lower margin is nearly straight and fringed with bristles; the posterior angle is rounded and unarmed. The antennules with their setæ extend beyond the beak; the pigment fleck is smaller than the eye and half way to the beak. The post-abdomen is long and narrowed toward the end; there are seven or eight anal spines, and two spines on the terminal claw. Length about 0.5 mm.

SUB-GENUS PLEUROXUS.

Section A. *Pleuroxus* (*verus*), Baird.

This group of lynceids is most obviously defined by the long "beak", formed by the extension of the chitinous covering of the head. (There is rarely a beak in the sense of that word as applied in the case of Scapholeberis or Daphnia, but the antennules are simply attached to low prominences on the under side of a broad shield-like projection of the shell.) This beak-like projection is acute and often long and either curved backward or even bent forward. The fornices, or lateral projection of the head-shield, are narrow. The form varies much, but is almost always very strongly convex above, and the posterior margin is thus only a fraction of the whole hight of the animal. In some American species the body is very much elongate, and these also depart from the characteristic habitus of the genus in having strong longitudinal striæ instead of reticulations. The lower posterior shell angle has teeth which, in a few cases, extend across the entire posterior margin. The post-abdomen is slender, usually truncate and armed behind with a single set of sharp teeth on either side; the terminal claw has usually two spines and may be serrate.

The male has a shorter beak, the post-abdomen is more or less modified, and the first foot has a powerful hook. The winter eggs frequently have a true ephippium; and sometimes this structure is like that of Chydorus, toward which the round forms of this genus seem to lead. There are upwards of a dozen valid species, several of which are American.

KEY TO SECTION A, PLEUROXUS VERUS.

§ Beak not curved forward.

A. Shell reticulate.

- (a) Post-abdomen very narrow.
    - 1. *P. hastatus*, Sars.
    - 2. *P. stramineus*, Birge.
- (b) Post-abdomen not very slender.
    - * Terminal claws with two spines.
        - 3. *P. trigonellus*, O. F. Mueller. (?)
        - ?. *P. ornatus*, Schœdler.
    - ** Terminal claws with a single spine.
        - 4. *P. acutirostris*, Birge.

B. Shell smooth, except upon the front margin.

- 5. *P. aduncus*, Jurine.

C. Shell striped.

- (a) Shell very long and low.
    - * With one tooth below.
        - 10. *P. unidens*, Birge.
    - ** Without a tooth; female with a hook upon the first foot.
        - 8. *P. hamatus*, Birge.
    - *** Without a tooth on the shell or claw on the foot.
        - 9. *P. affinis*, Herrick.
- (b) Shell high.
    - * Lower angle spined.
        - † Antennæ with eight setæ, anterior margin of valves toothed.
            - 7. *P. denticulatus*, Birge.
        - †† Antennæ with seven setæ.
            - 6. *P. bairdii*, Schoedler.
    - ** Whole posterior margin of shell spined (Percantha.)
        - 11. *P. truncata*, O. F. Mueller.

§§ Beak procurved (Rhypophilus.)

A. Shell reticulate.

- * Faintly and regularly.
    - 13. *P. glaber*, Schoedler.
- ** Strongly and irregularly.

14. *P. personatus*, Leydig.

B. Shell striped.

* Posterior margin toothed.

12. *P. procurvus*, Birge.

** Only lower angle toothed.

15. *P. uncinatus*, Baird.

Sp. 1. **Pleuroxus hastatus,** Sars.

(Plate I. Fig. 16.)

Pleuroxus lævis, SARS.
Pleuroxus hastatus, P. E. MUELLER.

Form somewhat oval, dorsal line strongly curved, posterior margin short, with a tooth below; head short, beak very long, straightish; shell obscurely reticulate. Post-abdomen very long, narrow, with small teeth; claw with two basal spines. Color corneous. The sculpture consists of faint reticulations. The ephippium forms a truncation of the upper part of the shell. Length 0.50—0.55 mm. The male has a shorter beak; the first foot has a weak hook, and the spermatozoa are spherical.

? Sp. 2. **Pleuroxus stramineus,** Birge.

This form is the American representative of the preceeding, if not identical with it. Birge mentions minute striæ in the meshes. P. stramineus is said to be lower than P. hastatus, while its beak is shorter. Undoubted specimens of P. denticulatus exhibit the same differences, an increase in the convexity of the shell accompanying an increase in the length of beak. The form of the abdomen appears nearly identical, if we compare P. E. Mueller's plate IV, fig. 18, with the outline given by Birge at plate II, fig. 11. The color in both is deep, especially during the period when the winter egg is forming. The direction of the reticulations is said to differ, but P. E. Mueller's figure does not furnish positive evidence ot this. Length C.6 mm.

Sp. 3. **Pleuroxus trigonellus,** O. F. Mueller.

Lynceus trigonellus, O. F. MUELLER, LIEVIN, LILLJEBORG, LEYDIG, FRIC.
Pleuroxus trigonellus, SCHOEDLER, P. E. MUELLER, KURZ.
? *Pleuroxus ornatus*, SCHOEDLER.

Dorsal line strongly arched; the beak rather long, straightish; pigment fleck smaller than the eye. Shell faintly reticulate, the markings consisting of transparent ridges. Post-abdomen widest in the middle, attenuated slightly toward the end, which is truncate; claw large, with one long and one very small basal spine. The anal margin of the post-abdomen has a series of small spines, and the lower shell-margin is hairy. The post-abdomen of the male is somewhat as in Crepidocercus, and densely hairy; the first foot has a moderate hook.

To judge from Kurz's statements, P. ornatus, Schoedler, is not specifically distinct. Not yet identified in America.

Sp. 4. **Pleuroxus acutirostris,** Birge.

This form, with Harporhynchus, imitates in some respects the Alonellæ, from which they differ in having the beak elongated and recurved. Birge's description does not state what the form of the fornices is, but he intimates that the general resemblances are with Pleuroxus. The general shape is as in P. hamatus.

"The post-abdomen is broad, compressed, truncated, with numerous fine caudal teeth. The terminal claws have only one basal spine." "The valves are reticulated as in P. [Alonella] insculptus, although not so plainly." Length 0.35 mm. Southampton, Mass.

Sp. 5. **Pleuroxus adunctus,** Jurine.

Monoculus adunctus, JURINE.
Pleuroxus adunctus, SCHOEDLER, P. E. MUELLER, KURZ.

Very like P. trigonellus, but with the back more strongly arched. The anterior part of the shell is striped. The beak is shorter than in P. trigonellus, but no other permanent differences are discoverable. The temptation to believe this a mere varietal form of P. trigonellus is great. Indeed, four species (the two here noted, P. bairdii and P. denticulatus, Birge,) are very nearly related. The ephippium, where known, is marked by minute punctation and a darker color.

Sp. 6. **Pleuroxus bairdii,** Schoedler.

Pleuroxus trigonellus, BAIRD.
Pleuroxus bairdii, KURZ.

This form, so far as can be gathered from Baird's brief description and figures, differs from the others in having the shell marked by straight parallel lines running diagonally backward and upward, and in lacking one of the terminal bristles on the 5-setose ramus of the antennæ. The first is a possible but unusual structure, while the second might result from an overlooking of the very small seta which fills this place in the other forms. Baird himself did not distinguish it from P. trigonellus.

Sp. 7. **Pleuroxus denticulatus,** Birge.

(Plate G. Figs. 12—13.)

Resembling very closely P. adunctus, which, however, has a broader post-abdomen than the ordinary P. denticulatus. The posterior angle of the shell is armed with from one to four (generally three) teeth. The beak is very long.

The character most emphasized by Birge is a series of teeth along the anterior margin of the valves. The same thing is found in P. procurvus, as I have repeatedly satisfied myself. In certain positions these teeth do not show, or the smaller teeth on the lower margin only appear. P. adunctus, as figured by Schoedler, has similar teeth on the lower margin, and very likely has them anteriorly. The edges of the valves are heavily fringed with pectinate setæ. The male has a shorter beak and the post-abdomen simply rounded without the peculiar modification seen in P. adunctus.

There seem to be two varieties in Minnesota both of which have the characteristic irregular striations of the shell, which radiate from an irregularly marked or unmarked area in the center toward the edges; both have the toothed posterior angle and the serrated posterior angle and the serrated anterior margin. But the common form is much longer, with the dorsal margin less convex and the beak shorter. The robust form has a larger pigment fleck, while the post-abdomen is shorter and more robust, resembling more nearly Schoedler's figures of the abdomen of P. adunctus. There is another variation or abnormality, in which the lower margin is quite concave. The resemblance to P. procurvus is remarkable in some phases.

I have collected this species in Blount springs, Ala., in the St. Croix river, and at various intermediate points, as well as very often in Minnesota.

Sp. 8. **Pleuroxus hamatus,** Birge.

(Plate H. Fig. 1.)

This species is smaller than those of the preceding group and forms a transition to the two next to be described in the greater elongation of the shell, which is, however, higher and more strongly arched. The head and beak are much as in P. denticulatus. The lower margin is concave posterior to the middle and slightly convex at the posterior angle, which is unarmed. The lower margin is hairy. The markings are as in P. denticulatus, but, in addition, there is a set of horizontal striæ all over the shell. The post-abdomen is widest in the middle and almost exactly as in P. denticulatus. The first foot bears a claw such as ordinarily distinguishes the males.

The only specimens which I have seen were from the Tennessee river, near Waterloo, and near Decatur, in Alabama. My notes contain no reference to the minute striations, which could perhaps be hardly seen with the instrument employed. The process of the labrum is long and rather acute, the beak moderate, and the pigment fleck very large. The markings on the anterior of the valves are irregular and are inter-connected by cross lines or anastomoses. Ova two. (The genus Anchistropus has a hook upon the first foot, but is like Chydorus.)

Sp. 9. **Pleuroxus affinis.** (Sp. n.)

(Plate H. Fig. 2.)

A small species with elongated shell and longitudinal striæ, forming a link between the preceding and the next, to which it is closely related. Shell broadest in front, upper contour nearly straight; anterior part of the lower margin evenly arched, posterior margin rather low. Head very short; beak very long, narrow and somewhat incurved; antennules and antennæ very small; eye evidently larger than the pigment fleck. The post-abdomen is as in P. denticulatus, or a little longer proportionately. The markings, so far as observed, consist of diagonal, faint, numerous and parallel lines posteriorly, and others springing from the anterior margin. There is no tooth behind; the teeth on the post-abdomen are small and not numerous. The upper margin of the shell is not sharp but rounded. Thus this pretty and unique form is clearly distinguished from all its allies althongh unfortunately only this very imperfect description and schematic figure can be given. Found in Weakly pond, Culbert county, near Florence, Alabama, where with an Alona, Chydorus sphæricus and Scapholeberis, it formed the cladoceran fauna of the pool.

Sp. 10. **Pleuroxus unidens,** Birge.

(Plate F. Fig. 15).

An extreme among these elongated species, the length of body falling little short of double the hight. The dorsal line is very flat and slightly but evenly arched; the lower margin is evenly convex or nearly straight, covered by long pectinate bristles. The head is short, and the beak is long and sharp; the antennules are of moderate size, with a lateral seta one-fourth from the end; pigment fleck less than the eye; antennæ rather long, with strong thorns on the terminal joints. The post-abdomen is long, as in P. hastatus, sides nearly parallel; anal teeth sharp, small and numerous; claws pectinate, with two strong basal spines. The shell is strongly striate with longitudinal striæ, which are parallel with the different margins. Birge says that there is a reticulated area. The lower angle is rounded, and anterior to it is a small tooth directed backward. This species is distributed throughout the Mississippi valley. I have notes of it from Swan lake, near Decatur, Alabama. It is often rather abundant about Minneapolis, but is thought by Birge to be absent from the eastern states. Almost all the specimens I have seen are very dark, often brown, so as to appear to the eye like dark specks as they swim about. The length varies from 0.55 mm. to 0.85 mm. About 0.60 mm. is a common size, according to my observation. Birge mentions a rudimentary sixth foot in this species. This organ is found in Eurycercus and other lynceids, according to Schoedler.

Sp. 11. **Pleuroxus truncata,** O. F. Mueller.

Lynceus truncatus, MUELLER, KOCH, ZADDACH, LIEVIN, FISCHER, LILLJEBORG, LEYDIG, FRIC.
Percantha truncata, BAIRD, SCHOEDLER, KURZ.
Pleuroxus truncatus, P. E. MUELLER.
Percantha brevirostris, SCHOEDLER.

This species is widely distributed in Europe, but is replaced in America by the following. The shell is high, the dorsal contour arched; beak rather long and straight; lower margin slightly convex, setose; posterior margin straight, armed with very strong teeth entirely across it; the anterior margin also is dentate, as in the next. The valves are covered with strong striæ, springing from the anterio-central part and radiating toward the free margins. The post-abdomen is of moderate size and in form much as in the next. The ephippium causes a considerably change in form and coloration. In the male the beak is shorter, and the abdomen has finer teeth. The first foot has an extraordinarily large hook. The length is about 0.5 mm. to 0.6 mm. Percantha brevirostris, Schoedler, differs in the length of the beak only.

Sp. 12. Pleuroxus procurvus, Birge.

(Plate E. Figs. 3, 4.)

In size and general appearance this most interesting species is similar to the above, and, especially, to P. denticulatus. The general form and even the details of structure agree almost to identify with the latter. The structure of the posterior margin is like Percantha, while the rostrum is bent abruptly upwards as in Rhypophilus. In small individuals the length is greater proportionally. The lower margin is slightly convex or nearly straight, and fringed by bristles which are stronlgy pectinate; the anterior and lower margins are toothed as in Percantha. The shell gland is more as in the Daphnidæ than most lynceids. The number of posterior teeth is variable. The ephippium is as in P. denticulatus. Length 0.40 mm. to 0.50 mm. Not rare, but less common than P. denticulatus. The male post-abdomen is like that of P. denticulatus; the rostrum is as in the female.

Of the species following it may suffice to say that they are corpulent, filth-loving representatives of P. trigonellus, P. adunctus and P. bairdii, respectively, which have turned up their noses at a superficial existence and buried themselves in the mire and debris at the bottom of the pools. It might be fanciful to assume that the curved snout is used for "rooting," but the fact that these "Schmutzpeterchen" lynceids would find a long straight beak in the way is suggestive.

Sp. 13. Pleuroxus *(Rypophilus)* glaber, Schoedler.

Pleuroxus personatus, P. E. MUELLER.

The shell is high and squarish, the fornices narrow, the beak slightly pro-curved, the lower margin nearly straight, with two or more teeth at the posterior angle. The antennæ have seven setæ only. The male is almost exactly as that of P. trigonellus. Length 0.55 mm. to 0.65 mm.; male 0.5 mm.

Sp. 14. Pleuroxus *(Rypophilus)* personatus, Leydig.

That this species is really distinct is by no means certain; however, it is stated that the shell is less regularly and more markedly reticulated, and the markings lack the elevations described under P. trigonollus, which are present in the previous species. It lives in filth and covers itself with it.

Sp. 15. **Pleuroxus** *(Rypophilus)* **uncinatus**, Baird.

The shell is ridged with lines running upward and backward, as in P bairdii; the lower angle of the shell has three teeth, and the beak is more horizontal than in the above. In size and characters this is almost identical with P. bairdii, with which it occurs in England.

This completes the list of swine-like members of the genus; these well deserve to be studied from a morphological stand-point.

Pleroxus nasutus, Gay, is a poorly described form from Chili, resembling, according to Schoedler, P. ornatus = trigonellus.

A species of Percantha (Lynceus armatus, Gay) is found in Chili.

NOTE TO PLEUROXUS.—The two species P. unidens and P. affinis are quite diverse from the type of the genus and approach in some respects to Leptorhynchus. P. affinis, particularly, has a recurved beak. I am in doubt about P. hamatus and P. acutirostris, which is said to be reticulated; but it seems likely that the species above mentioned stand in closest relation to Leptorhynchus.

Section B. *Leptorhynchus*, Herrick.[1]

The species for which Sars formed the genus Harporhynchus is of Alona-like habit, but has a beak which exceeds that of any known Pleuroxus in length, being simulated in this respect by the American P. acutirostris, which is, however, in other respects more nearly allied to Pleuroxus.

Leptorhynchus falcatus, Sars.

Harporhynchus falcatus, SARS.
Alona falcata, SARS, P. E. MUELLER.

Body oblong, arched above; ventral margin nearly straight, setose, with a spine at the posterior angle; beak strongly curved, folded laterally; pigment spot larger than the eye. The post-abdomen is wide, sides nearly parallel, armed with a few strong teeth below and a lateral line of spines; caudal claw with a single small basal spine.

VIII.—GENUS PHRIXURA, P. E. Mueller.

Oblong, wide; posterior shell-margin little less than whole hight. Post-abdomen terete, obtuse at the end, which is armed with a cluster of spines of which the terminal ones are similar to the others.

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[1] Harporhynchus is preoccupied in ornithology.

Sp. 1. **Phrixura rectirostris,** P. E. Mueller.

(Plate I. Fig. 18.)

Beak acute; shell striated longitudinally, slightly arched above; ventral margin rounded, with a round and unspined angle behind. Length 0.5 mm. Not yet encountered in Minnesota.

IX.—GENUS CHYDORUS, Leach.

This genus, if it be really of generic value, contains minute rotund animals which appear in the water like animate pin-heads of small size. Their motion is a rolling, wavering hobble; and they live by preference upon vegetation, or in slime at the bottom of pools. Occasionally they may be seen in sunshiny weather, disporting themselves near the surface in immense numbers. There are two common species, and six more which are more rare or in part not valid.

The sexual period occurs at two different periods (i. e., May—June, and December), but in probability is not confined to any periods. The males, which only rarely are found even in these periods, have the abdomen narrowed or excavated to accomodate it to the peculiar alteration of the brood-cavity which takes place in the sexually mature female. The connection takes place by the insertion of the abdomen within this chamber, which is facilitated by the reduced size of the abdomen. The modification of the shell of the brood-cavity above referred to consists in the thickening of the wall posteriorly, which may or may not result in the deforming of the shell, as shown in plate F, fig. 7, taken from Kurz. This may be termed an ephippium, although it differs somewhat from the modified shell so called in Daphnia. The male element consists of nearly round nucleated cells, and the opening of the vas deferens is anterior to the terminal claws. The members of this genus are among the most minute forms of the family or the entire group. Concisely put, the characters are as follows:

Form globose, not obviously truncate behind; head terminating in a sharp, long, curved beak, which lies close upon the anterior margins of the valves; antennæ short; eye larger than the pigment fleck; abdomen flattened, excavated in the male; intestine with no anterior cæca, doubly convoluted, with an anal cæcum. Three species found in Minnesota.

Sp. 1. Chydorus sphæricus, Mueller.

(Plate F. Figs. 4, 7, 8 and 10.)

Lynceus sphæricus, O. F. MUELLER, M. EDWARDS, KOCH, ZADDACH. LIEVEN, FISCHER LILLJEBORG, LEYDIG, TOTH, ZENKER, FRIC.
Monoculus sphæricus, JURINE.
Chydorus muelleri, LEACH.
Chydorus sphæricus, BAIRD, SCHOEDLER, P. E. MUELLER. LUTZ, KURZ, BIRGE.

Form nearly spherical, as seen from above broadly oval; in young specimens truncate behind; antennules of moderate size, in the male very large, with curved flagellum near the middle of anterior margin; pigment fleck often nearly as large as eye; beak of moderate length, blunt in the male; first foot strongly hooked in the male; post-abdomen short, broad, rounded at the end, armed with 8—9 sharp teeth; shell reticulated with polygonal meshes. Color light, unspotted. Length 0.50 mm.

This species occurs in Spring earlier than most forms, and is ranked as the most abundant of the micro-crustacea, being found over the whole circumpolar land-area. The ephippium for the winter egg was observed by Kurz, but the period at which it is formed seems variable.

C. sphæricus of a previous report seems to have been the following species which is more common in Minnesota in the clearer lakes. A small form in our large lakes measures 0.3 mm.; it may be distinct.

Sp. 2. Chydorus globosus, Baird.

(Plate F. Figs. 1, 2, 3 and 9.)

Chydorus globosus, BAIRD, LILLJEBORG, SCHOEDLER, LEYDIG, P. E. MUELLER, FRIC, KURZ, BIRGE.

Form globose, very broad; antennules very large with a strong lateral seta on a small elevation; swimming antennæ exceedingly small; the shell gland is well developed; the pigment fleck is much smaller than the eye; beak very long and incurved; post-abdomen rather long, more slender than the last, broader near the end which is truncate, bearing about 20 spines on the margin near which is a lateral series of minute bristles; the terminal claws are straightish, spined along the basal half, and have an accessory spine; the shell is very indistinctly reticulated and spotted; color dark; length 0.7-0.8 mm.; male 0.55 mm. The males have the abdomen very narrow for the entire length.

This species is considered rare elsewhere, but is not infrequent in August near Minneapolis.

Sp. 3. **Chydorus ovalis**, Kurz.

(Plate F. Fig. 11.)

Form oval, nearly twice as long as high; beak long; antennules two-thirds as long as the beak, with two elongated sensory filaments above the others; pigment fleck nearly as large as the eye; antennæ small; shell margins heavily fringed anteriorly; post-abdomen of moderate size, rounded at the end, with about 8 teeth near the end; shell smooth. Length 0.4 mm.

This species is rather near C. sphæricus, differing in having the shell smooth, antennæ shorter, and beak longer. This species is not yet known in America.

Sp. 4. **Chydorus cælatus**, Schoedler.

(Plate F. Fig. 12.)

Chydorus adunctus, SCHOEDLER.

This small species is about 0.4 mm. long, and resembles the young of C. globosus in form, from which as well as from all known species it is distinguished by the markings of the shell, which consist of series of rounded elevations (or depressions?) arranged parallel to the lower margins of the shell and head. The description is very incomplete, and the only other author who appears to have seen the animal is Kurz, who adds that the sensory filaments of the antennæ are unequal in hight, and that the so called elevations are really depressions. A form with a few depressions about the edge and characters of this species was once seen in the vicinity of Minneapolis.

Sp. 5. **Chydorus nitidus**, Schoedler.

(Plate F. Figs. 5, 6.)

Shell smooth and regularly punctate; the head resembles C. sphæricus, but the pigment fleck is much smaller than the eye, to which it is much nearer than to the end of the beak; the post-abdomen is broader near the end, and bears a row of 10—12 teeth on either side.

(?) Sp. 6. **Chydorus latus**, Sars.

Very possibly a variety of C. globosus, from which it differs in the shorter beak and greater size. Length 0.66 mm.

Sp. 7. Chydorus piger, Sars.

Sub-rotund, prominent above, sinuate behind; lower and posterior margins rounded, lower margin ciliated. Head movably united to the body; beak long, separated by an indentation from the head shield. The shell is broad, as seen from above. Shell punctate anteriorly and marked below by indistinct oblique striæ. Antennules with seven setæ and two small thorns on the end of each ramus. Post-abdomen truncate; the terminal claws with a minute tooth at the base; posterior margin sinuated, rounded below and there densely armed with minute teeth. Abdominal setæ long and flexible. Pigment fleck of medium size, much nearer to the eye than to the beak. Length about 0.33 mm.

(?) Chydorus latifrons, Dana. (U. S. Exploring Expedition, Rep. on Crust., vol. II, p. 1274.)

Very tumid; in side view rotund, head not separate, very short-beaked; beak slender and close to the body, acute; in upper view animal very broad, truncate anteriorly, the front thereby nearly as broad as the body; behind low, triangular and obtuse. Feejee islands.

(?) Chydorus albicans, Gay,

from Chili, is imperfectly described; but it is interesting to note the occurrence of this genus there.

X.—GENUS ANCHISTROPUS, Sars. (?)

Very similar in form to Chydorus; valves gaping below anteriorly; antennules small; process of labrum rounded. Post-abdomen attenuated toward the end, densely covered with fine teeth; terminal claws denticulate. First foot with a powerful claw, protruding beyond the shell. Eye very large. Shell indistinctly reticulate. Sars says of his Anchistropus emarginatus that on cursory inspection it would be taken for the young of Chydorus globosus. He found but few specimens, about 0.35 mm. long. The suggestion is still possible that the young males of some Chydorus are here mistaken for a new genus. The males of Chydorus globosus were not known till 1878, and their early form is still unknown. The young females have a tolerably strong claw, though it is not much curved. I have once found a peculiar lynceid measuring 0.46 mm., with unevenly but distinctly reticulate shell, slender abdomen, and a strong claw which was dentate. There were several young (more than two), and the shell in these was more regularly reticulate. All efforts to find a second specimen failed, and the one seen was somewhat mutilated; hence I am unable to determine its real position.

XI.—Genus Monospilus, Sars.

Head separated by a depression from the body; shell high, compressed, posterior margin somewhat less than the greatest hight of the shell. Post-abdomen broad, ornamented with lateral and posterior spines; claws large, with a single basal tooth. The compound eye is absent, its place being taken by the pigment fleck, which is the functional eye.[1]

Monospilus dispar, Sars.

(Plate I. Fig. 21.)

Lynceus tenuirostris, FISCHER, Abh. ueber einige neue Daph. und Lynceidæ. p. 427, tab. III, figs. 9—10 (*fide Sars*).
Monospilus dispar, SARS, Crust. Cladoc. i Omgn. af Christiania, p. 165.
Monospilus dispar, MUELLER, Danmark's Clad., p. 196.

Shell roundish; ventral margin setose; posterior angle rounded, marked above with numerous impressions. Antennules small; antennæ long, with seven setæ. Post-abdomen short and broad, bearing a series of spines along the excavated posterior margin, and ornamented on the sides with clusters of bristles. The shell in old individuals is not moulted but remains as in Ilyocryptus, covering the greater part of the new shell. The figure shows an old individual with its successive coverings still clinging to it. Like Ilyocryptus, this animal passes its life in filth at the bottom of pools, and rarely emerges to the light of day. What little visual function there may be is vested in the larval organ.

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[1] So much interest attaches to this species that we reproduce the Latin description of Sars. "Testa in adultibus valvulis composita pluribus, altera alteri imposita, a latere visa lata, latitudine maxima in parte antica sita; margine superiore antice valde prominente, posteriore et inferiore ciliato rotundatis. Caput mobile, perparvum et valde depressum, supine impressione parva sed distincta, a testa cetera disjunctum, deorsum in rostrum rectum et breve apice obtuso exiens. Animal supra visum sat compressum, latitudine maxima capite majore ante medium sita. Pars superior testæ et capitis impressionibus numerosis rotundatis notata. Antennæ 1-mi paris minutæ structura ut in ceteris Lynceidis; 2-di paris sat longæ, ramo altero setas 4 et aculeum unum apicalem, altero setas 3 et aculeos duos, quorum alter longus articulo primo ejusdem rami adfixus est, gerunte. Postabdomen breve et latum, apicem versus truncatum; margine posteriore supra obtuse angulato, ad angulum inferiorem rotundatum seriebus duabus aculeorum inque lateribus setis vel spinulis brevibus numerosis præditum; ungues terminales ad basin aculeo longo armati. Intestinum, ut in ceteris Lynceidis, in thorace laquem fere duplicem format. Macula nigra unica minima prope basin antennarum 2-di paris; maculæ infra oculari in ceteris Lynceidis simillima, in capite conspicitur, quæ, quum oculus verus compositus in omnibus ceteris Crustaceis Cladoceris distinctus omnino absit, organum quamquam rudimentare visus habenda est. Animal parum pellucidum, colore fulvescente. Longit. parum supra $\frac{1}{3}$ mm"

The specimen from which the drawing was made measured 0.45 mm. The first glance at this rarest of all entomostraca affords proof of its unique character. The strongly arched shell is so compressed as to bear little resemblance to Chydorus. The dorsal line passes with little angle into the high posterior margin. There is a rounded angle below, armed with two teeth—the shortened representatives of the fringing spines of the straight lower margin. The head is depressed and very short, but the narrow beak is produced to below the margin of the valves. It is rounded so as to resemble, as seen in front, a duck's bill. The fornices are narrow and flare so that the eye is left partly exposed upon the side. The antennules are not long but slender. The labrum has a very large lamella, which is crenulate in front and acute below, the labrum proper being large. The systematic position of this genus is a matter of considerable interest, for it is the only member of the whole order in which the larval eye is the only one developed, and the first thought would be that this must be a primitive synthetic type, in other words, historically the oldest of Cladocera. Closer study does not warrant the theory. There is much to indicate that, though essentially lynceid, it stands in close connection with the higher members of the family and perhaps has more than a superficial resemblance to such degraded lyncodaphnids as Ilyocryptus. All things considered, however, our diagram stands with this genus as a degraded offshoot of the more typical stem of Lynceidæ.

SUB-ORDER II.—GYMNOMERA.

This group is easily recognized by the almost entire absence of the shell, which forms so conspicuous a part in the greater number of the Cladocera. Here it serves simply to form a pouch or brood-sac for carrying the eggs and embryos. The feet are nearly terete and prehensile, with but slight indications of branchial appendages.

FAMILY POLYPHEMIDÆ.

Feet five pairs. Antennæ with the rami three- or four-jointed.

I.—GENUS POLYPHEMUS, De Geer.

Head very large, separated by a depression from the compact body; shell covering but a part of the dorsal region. Feet all with an internal dentate, and an external lamellate appendage. Caudal seta upon a long process of the post-abdomen.

Sp. 1. Polyphemus pediculus, Linn.

(Plate B^1. Figs. 4—6.)

Monoculus pediculus, LINNÆUS, 1746. GMELIN, Linn. Syst Nat. FABRICIUS, Ent. Syst., etc. SULZER, Insecten. MANUEL, Encyclop. Meth.
Monoculus pediculus ramosus, DE GEER, Mem. pour serv. a l'Hist. des Ins.
Polyphemus oculus, MUELLER, Zool. Dan. Prod. et Entomost. CUVIER, Tab. element LATREILLE, Hist. Nat. Crust., etc. LEACH, Edin. Encyc.
Polyphemus stagnorum, LEACH, Dict. Sc. Nat. LATREILLE, Cuv. Rig. An. DEMAREST, Cons. Gen. Crust.
Polyphemus pediculus, STRAUS, Mem. Mus. d'Hist., etc. M. EDWARDS, Hist. Nat. Crust.
Monoculus polyphemus, JURINE, Hist. Nat. Monoc.
Cephaloculus stagnorum, LAMARCK, Hist. An. Vert. BOSC, Man. d'Hist. Nat. Crust.
Monoculus oculus, GMELIN, Linn. Syst. Nat.
Scalicerus pediculus, KOCH, Deutsch. Crust.
Polyphemus pediculus, BAIRD, Brit. Entom.
Polyphemus oculus, LIEVIN, Branch. d. Danz.
Polyphemus stagnorum, FISCHER, Ueber die in d. Umg. von St. Petersburg, vorkom. Crust.
Polyphemus pediculus, LILLJEBORG, De Crust. ex ord. trib.
Polyphemus oculus, LEYDIG, Naturg. d. Daph.
Polyphemus pediculus, SCHOEDLER, Neue Beitr. zur Naturg. d. Cladoceren.
Polyphemus kochii, " " " "
Polyphemus oculus, " " " "
Polyphemus pediculus, P. E. MUELLER, Danmark's Cladocera. KURZ, Dodekas neuer Cladoceren. WEISMANN, Beitr. zur Naturg. der Daphnoiden. BIRGE, Notes on Cladocera.
Polyphemus occidentalis,[1] HERRICK.

There are two well-marked varieties of this species: one is found commonly in the clear lakes; the other, which I have only once seen, was found in a very shallow weedy marsh. The difference in size is quite remarkable. Our ordinary form measures less than 1 mm. The larger form, including the stylets, is 1.6 mm. The ordinary variety, although highly colored, is yet transparent, while the large variety is deep red and quite opaque. The relationship between the two forms is quite like that maintaining between Diaptomus stagnalis and D. sanguineus. Some slight structural differences are observable between the two varieties, as in the form of the antennules, yet quite insignificant when compared with the striking difference in size and coloration. Number two may be called

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[1] Polyphemus occidentalis, Dekay — Limulus.

Sp. 2. Polyphemus stagnalis. (Sp. n.)

In order to make the relation clear between these forms, I add measurements of this species, following each with the corresponding measurement of P. pediculus in parenthesis; animals of the same age, as far as possible, being chosen. Head (capsule of eye) 0.3 mm. (0.2 mm.); head and thorax 0.7 mm. (0.45 mm.); abdomen 0.7 mm. (0.56 mm.): caudal stylet 0.36 mm. (0 26 mm.); caudal filaments 0.36 mm. (0.3 mm.). Whole length of antennæ 0.54 mm. (0.42 mm.); first, second and third joints of the 3-jointed ramus 0.08, 0.06 and 0.10 mm., respectively. The formation of the resting eggs or "dauer ei" seems to go on at the same time with the parthenogenetic reproduction.

II.—GENUS BYTHOTREPHES, Leydig.

Much like Polyphemus, but the external appendage of the feet is rudimentary, and the abdomen extends out into a most enormous spine. The single species is that described by Leydig as B. longimanus, which was found in the stomach of Coregonus wartmanni. B. cederstromii, of Schoedler and P. E. Mueller, the latter author now identifies with the above, and concludes that the supposed differences arose from "l'etat de maceration des examplaires examines." (*Les Cladoceres des Grands Lacs de la Suisse*, p. 11.) This species may be looked for in the depths of the Great Lakes. (See plate U, fig. 10.)

III.—GENUS PODON.

IV.—GENUS EVADNE.

These are compact oval forms confined to the sea. See Claus, *Zur Kenntniss des Baues der Polyphemiden*, Vienna, 1877, for the best account of the anatomy.

FAMILY LEPTODORIDÆ.

Feet six pairs. Antennæ with both rami four-jointed. Body elongated, not curved, shell very much reduced.

Leptodora hyalina, Lilljeborg,

(Plate N. Figs. 6, 7),

the only species, is found rarely in the larger lakes of Europe and America.

See *Bau und Lebenserscheinung von Leptodora hyalina*, Weismann, 1874; also, *Om en dimorph Udvikling samt Generationsvexel hos Leptodora*, G. O. Sars, 1873; also, *Bidrag til Cladocerenes Forplantningshistorie*, P. E. Mueller.

The work of Sars is particularly valuable, showing that the young produced from the winter eggs pass through a metamorphosis not experienced by the summer or parthenogenetic brood. P. E. Mueller mentions the pathological condition induced by the plants of the Saprolegnia.

CHAPTER III.

ORDER COPEPODA.

This extensive order contains minute and predominatingly predaceous animals which constitute no inconsiderable part of the fauna of fresh and salt waters. They serve a beneficent purpose both as scavengers and as providing food-supply for the fry of fishes and other aquatic animals.

Copepods are never enclosed in a bivalved shell but ordinarily exhibit a more or less elongated cylindrical form composed of two obvious sub-divisions. There are a few species which, by the great prolongation and expansion of some of the tergites or dorsal shields, seem to simulate shelled crustacea. The anterior part of the body, or cephalothorax, is composed of ten somites which are frequently considerably united or fused. Five of these segments constitute the head and bear respectively the following appendages: first, a pair of several- to many-jointed antennæ which are never primarily sensory in function, although they usually are provided with sense hairs or other like organs; second, a pair of two-branched antennules, which sometimes become almost simple or prehensile; third, a pair of mandibles in the form of masticatory or piercing organs, these being usually provided with a palpus; fourth, a pair of maxillæ of various form and function; fifth, a pair of maxillipeds which not infrequently subdivide in later life to form what appear to be two distinct pairs.

The five thoracic segments have each a pair of swimming feet consisting typically of a two-jointed base and two like, three-jointed rami. The symmetry is frequently broken by the retardation of the development of the inner ramus, while the fifth pair of feet may become rudimentary and in various ways subserve the organs of sex. The five abdominal segments are nearly devoid of appendages and are continued posteriorly by two caudal stylets which bear strong setæ constituting, in many forms, a tail-fin or spring.

All copepods, even such as are, in later life, parasitic, begin their existence as free-swiming nauplii, such as are represented on plate S, fig. 13, and plate K, fig. 8.

Though the vast majority of genera and species are marine, it would seem that fresh-water copepods make up in the number of individuals what they lack in variety.

As we are dealing primarily with the fresh-water species, no lengthy description of the group is here necessary.

The earlier history of our knowledge of the animals of this order is given by Baird. According to this authority, the first to mention any fresh-water species of this group was *Stephan Blankaart*[1] in his *Schou-burg der Rupsen, Wormen, Ma'den, en vliegende Diekens tot Amsterdam.* *Leeuwenhoek* adds numerous interesting details and is accredited by Hoek with being to first to discover the relation between the remarkably diverse stages which occur in the history of the cyclops. However, it is evident that he had a very incomplete knowledge of the metamophoses.

De Geer gives rather characteristic figures of a cyclops in *Memoires pour servir a l'Histoire des Insectes*, vol. vii, 1778.

Mueller, in his great work on *Entomostraca*, adds new facts, defines species and forms the genus Cyclops.

Ramdohr in 1805 gave sundry additions to the knowledge of these animals in his *Beitraege zur Naturgeschichte einiger Deutschen Monoculus-arten.* In this work the post-embryonic history is quite fully outlined.

Jurine, in his classic work *Histoire des Monocles qui se trouvent aux Envirous de Geneve*, 1820, crystallized what previous authors as well as his own original experiments had brought to light of the anatomy and biology of these animals.

Ferussac (Memoire sur deux novelles espices d'Entomostraces) redescribes known species.

Gunner, *Stroem*, and *Viviana*, seem to have had little effect on the knowledge of the group, though they wrote prior to Jurine.

A recent author attempts to revive the names of Jurine, though hitherto it has been thought hazardous to attempt a specific identification.

The German author, *C. L. Koch*, who only incidentally studied this group, distinguished more or less perfectly, a variety of species which have been reinstated in our literature by Rehberg. Although this proceeding seems quite unjust to the careful authors whose descriptions are recognizable in themselves, the law of priority must probably prevail. Koch's *Deutschlands Krustaceen* appeared in 1838.

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[1] Latinized *Stephanus Blanchardus*. Hoek recognized Cyclops brevicaudatus or C. bicuspidatus as the one described, chiefly through knowledge of the present inhabitants of the locality.

Baird's British Entomostraca, without greatly extending our knowledge of this order, put in readable form and made available to English readers what was known, and added interesting facts. He distinguished two families of Copepoda, (1.) Cyclopidæ, (2.) Diaptomidæ. The first included the genera (1.) Cyclops, (2.) Canthocamptus, (3.) Arpacticus, (4.) Alteutha; and the second the general (1.) Diaptomus, (2.) Temora, (3.) Anomlocera.

Fischer, who contributed not a little to our knowledge of the distribution of fresh-water Cladocera, was the next to describe valid species. He described the species found near Moscow and St. Petersburg, Russia.

Ouchakoff is likewise a Russian author, but his writings are quite unknown to me.

The justly famous Swedish naturalist, *W. Lilljeborg*, who has left his mark on so many branches of natural science, has not neglected the microscopic crustacea of his fatherland. *Om de inom Skaane foerekommande Crustaceer af ordningarne Cladocera, Ostracoda och Copepoda* is the somewhat formidable title of his work, published in 1855. He recognized the following genera of Copepoda: Diaptomus, Temora, Dias, Ichtyophorba, Tisbe, Tachidius, Harpacticus, Canthocamptus, and Cyclops. A species each of Diaptomus and Canthocamptus is described, and two species of Cyclops. (It would seem from authors' quotations that other species are described in an appendix, but the copy I have seen lacks this.) The author who has done most for micro-carcinology in general is *Carl Claus*, of Vienna. His principal works are:

1. "Das Genus Cyclops," etc. In *Wiegmann's Archiv fuer Naturgeschichte.* 1857.
2. "Weitere Mittheilungen ueber die einheimischen Cyclopiden." The same, 1857.
3. *Die Freilebenden Copepoden,* 1863.

The later work especially is indispensable to the student of Copepoda, though in reality it is more important in respect to marine Copepoda.

In the meantime a work appeared in Norwegian, with Latin descriptions, from the pen of *G. O. Sars*. This has been largely overlooked. It is, unfortunately, unaccompanied by plates, but the descriptions bear the stamp of the naturalist.

A little later a second brief contribution from this author was published, but I have not seen it.

Sir John Lubbock in 1863 describes species of fresh-water copepods, but the publication seems no longer necessary.

Heller, in Tyrol, *Fric*, in Bohemia, and *Uljanin*, in Asia, have studied the copepod fauna.

A Russian paper by *Poggenpol* and *Uljanin* is quoted as "A Catalogue of the Copepoda, Cladocera and Ostracoda of the vicinity of Moscow," by Rehberg, and as from the *Protokolle der kais.-naturw. anthropol. und ethnogr. Ges. in Moskau*, but by Cragin who publishes a translation apparently of the same paper, in part, as from the "Bulletin of the Friends of Natural History."

Hoek, in the *Tijdschrift der Nederlandsche Dierkundige Vereeniging* (Magazine of the Zoological Society of the Netherlands) 1875, and later in German in the *Niederlaendisches Archiv fuer Zoologie*, gave excellent figures and descriptions of some species which Claus had too hastily treated.

In 1878 *A. Gruber* gave descriptions of "Two fresh-water Calanidæ."

In the same year the first volume of *Brady's* fine "*British Copeoda*" appeared. A purely technical work and briefly written, it is yet very comprehensive and in the main reliable. This is a worthy successor of the Ray Society's earliest publication on entomostraca —Baird's great work.

In the sixth vol. of the *Abhandlungen d. naturwissenschaftlichen Vereine zu Bremen*, Herman Rehberg gives a systematic review of synonomy, and in the revision unites several species in a manner that the present writer had independently been driven to do. It is probably impossible either to substantiate or positively deny some of this writer's identifications of the species of the older authors.

This paper also contains an observation of a hermaphroditic cyclops, which it is interesting to compare with similar anomalies, described by Kurz in Cladocera.

In the vii Band of the same periodical, Rehberg adds to and modifies some of the views expressed above. In the same number is a description of a new species of Temora by *Poppe*. (The same species occurs in the semi-saline waters of the Gulf of Mexico, and had well-nigh gone into print under a new name when this was seen.)

In the above review we have noticed only the more important foreign works on the Copepoda and those including fresh-water forms. *Dana's* magnificent *Crustacea of the Wilkes' Exploring*

Expedition is not included because it is essentially restricted to the marine species, the few descriptions of fresh-water species, being quite valueless. Among important contributors to the exclusively marine Copepoda, are *Boek (Oversigt over Norges Copepoder* and *Nye Slægter og Arter af Saltvands-Copepoder)*, *Brady* and *Robertson*, *Lubbock* and *Claus*.

The history of the American literature can be quickly traced.

Say described imperfectly an American species of Cyclops in 1818. *Haldeman* describes in vol. viii, of the Proc. of Phila. Academy of Science, p. 331, Cyclops setosa (which may be C. serrulatus). *Pickering* very imperfectly described a new genus of copepods from lake Ontario in Dekay's *Zoology of New York*. This genus is, most likely, Epischura of Forbes and, in strictness, ought to rank it. In 1877 appeared "A List of Illinois Crustacea," by *Prof. Forbes*, in which two species of Copepoda were described which may rank as the first descriptions at all adequately framed of American members of the order. In the *annual report of the Minnesota state geologist* for 1878, a brief article by C. L. Herrick outlined, in the light only of the then English literature, the micro-crustacea of Minnesota. No attempt was made to treat the Copepoda, but two species of Diaptomus are indicated which will prove valid. Occasional papers in the *American Naturalist* and elsewhere follow till, in July and August of 1882, Prof. Forbes added two new genera and several species of Copepods, constituting by far the most considerable addition to the subject yet produced.

In the *report of the state geologist of Minn.* for 1881, C. L. Herrick makes a considerable addition to the knowledge of American Cyclopidæ, enumerating ten species, of which six seemed new. This writer also describes a new genus and several new species of Calanidæ, some of which unfortunately are identical with those described by Forbes and published about simultaneously.

Several articles in the *Naturalist* bring the bibliography up to May, 1883, when *F. W. Cragin* published in the *Trans. Kansas Academy of Science*, "A Contribution to the History of the Fresh-water Copepoda." In this paper ten species of Cyclops are described or mentioned. The author ignored previous American literature and thus adds somewhat to synonomy. The plates are lithographic, and are carefully, if not artistically, prepared. A valuable feature is the translation of the descriptions of Poggenpol's species from the Russian.

These papers, together with the outline presented beyond, it is hoped, will form a basis for future work.

Since writing the above, it is brought to my notice that in April, 1881, *V. T. Chambers* gave some account of a species of the Harpacticidæ referred by him to Tachidius. This species is particularly interesting on account of its novel habitat. Tachidius (?) fonticola, Cham., is found in the saline waters of Big Bone Springs, Ky., and thus is very distant from any marine congeners. It is perhaps doubtful if the generic reference can be sustained, but the species is worthy of further study. The Diaptomus described by the same author is hardly recognizable.

FAMILY CALANIDÆ.

This group is pre-eminently marine and contains diverse and graceful forms mostly with very elongated bodies and antennæ. Of the six genera here enumerated as more or less habituated to the use of fresh water, two are found as yet only in America and one is confined to Europe.

Heterocope, namely, is very near Epischura, both being restricted to fresh water. Diaptomus and Osphranticum are likewise only accidentally found in the seas, though their nearest allies are marine. The genus Limnocalanus is as yet found in America only in the Great Lakes.

In the distribution of genera we here follow Brady, whose definition of the family Calanidæ, including Calanidæ and Pontellidæ of authors, we quote: "Body elongated; composed of from ten to twelve [obvious] segments. Abdomen nearly cylindrical, much narrower than the cephalothorax and prolonged at the posterior extremity into two more or less cylindrical caudal branches [stylets]. First segment of thorax often anchylosed with the head; fourth and fifth segments also often coalescent. Head only rarely divided into two segments. Anterior antennæ very long and composed of twenty-four or twenty-five joints; that of the right side in the male often modified for grasping [geniculate]. Posterior antennæ large, composed of a basal joint, from which spring usually two branches, the primary branch consisting of two, the secondary of several joints. Mandibles strongly toothed at the apex, palp (usually) two-branched. Maxillæ strong, and provided with a many-lobed palp. Foot-jaws strongly developed: first pair very broad; the basal joints having on the inner margin wart-like processes, from which spring long ciliated bristles; the distal extremity divided into three short joints which are thickly beset with strong and long, ciliated setæ; second pair longer and more slender, basal portion forming two long oval joints; apical portion usually 4-6-jointed. First four pairs of feet 2-branched, the outer branches always three-jointed. Fifth pair either like the foregoing, or much modified, unlike on the two sides, and in the male forming clasping organs. A heart is present. Eyes either median and stalked or paired (lateral) and sessile; in the latter case being often coalescent and composed of several lenses. Sexual organs in the female symmetrical, in the male asymmetrical. Ovisac single, borne in front of [below] the abdomen.

I.—GENUS HETEROCOPE, Sars.

Cephalothorax 7-jointed; abdomen of female three-jointed; caudal stylets short, with three large setæ and other small spines. Antennæ long, slender. 25-jointed; right male antenna geniculate, the six joints preceding the nineteenth swollen slightly, the previous ones coalescent; external ramus of the antennules 7-jointed; labrum tri-lobate; feet of the four anterior pairs with the inner rami one-jointed; fifth feet of female with a single ramus, three-jointed, with a terminal spine. The right foot of the male is cheliform, four-jointed, second joint extending into a long cylindrical process, the terminal joint with two apical claws.

The writer is familiar with but three species—H. appendiculata, *Sars*, H. saliens, *Lilljeborg*, (= H. robusta, *Sars*,) and H. alpina, *Sars*. None of these have as yet been positively identified in America* and their place seems supplied by the following genus.

II.—GENUS EPISCHURA, Forbes.

(= Scopiphora, Pickering?)

Undoubtedly the most remarkable of fresh water copepods are the two American species of this genus. It is not yet certain that the second species may not be a young stage of the first but it seems quite improbable.

Related with Heterocope, Sars. The antennæ are 25-jointed, the right of the male being geniculate. The thorax is 6-jointed, the last two segments being partially coalesced. The abdomen is five-jointed in the male and four-jointed in the female, one branched, in the male modified for prehension. Abdomen of male with a prehensile appendage on the left side, often more or less distorted. Inner rami of swimming feet one-jointed. Caudal stylets with three long setæ. The first mention of an animal of this genus seems to be Pickering's description of Scopiphora vagans from deep water in lake Ontario. It seems almost certain that the species so imperfectly described in Dekay's Crustacea of New York, is none other than a species of Epischura, but I hesitate to substitute for a name accompanied by good descriptions and figures, and one which has already been incorporated, to some extent, into our literature, one which is founded on a description so imperfect and general that one incidental character alone enables one to guess its application. The following is Pickering's description:

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*Heterocope is said by Patten (Cragen) to be common at Watertown, Conn.

" Body small, eye single, near the anterior margin of the shield. Antennæ large, and as long as in the preceding genus [Cyclops], and has the same motions in the water. Abdomen terminating in two styles, each with three setæ; last or three last joints. Ovaries none; legs spiny."

What is meant by the "brush" fails to appear, unless the specimens were ornamented with some parasitic plants or animals. The three setæ of the caudal stylets and long antennæ will place this form in no American genus save Epischura. But even this statement of Pickering may be held doubtful.

Sp. 1. **Epischura lacustris,** Forbes.

(Plate Q. Fig. 15.)

" The scond segment of the abdomen of the male is twice as long as the first, and produced to the right as a large, elongate, triangular process, somewhat hooked backwards at the tip. The third segment is similarly produced, but rounded and expanded at the tip, which is roughened before and behind.

From the right side of the fourth segment arises a stout process bearing at its apex a hatchet-shaped plate with seven broad obtuse serratures on its anterior margin. This process is roughened behind, where it is opposed to the concave side of the left ramus of the furca. From the same side of the fifth segment, a short flattened plate, of a spatulate or paddle-like form, extends forward above or beyond the toothed process just mentioned.

The antennæ are 25-jointed, and reach to the second segment of the abdomen. There are especially prominent sensory hairs on the first and third joints, borne at the tips of long spines. The antennules are short, the ramus apparently but three-jointed, the short, median joints common in this appendage being only obscurely indicated. The mandible has but seven teeth, the first simple and acute, separated from the second by an interval about equal to the second and third, the second to the sixth bifid, the seventh entire and acute. The usual plumose bristle is replaced by a sharp, simple spine.

The outer ramus of the fourth pair of legs has two teeth at the outer tip of each of the two basal joints. The terminal joint of this ramus is armed as follows: a short simple spine at middle of outer margin and another at the distal outer angle; a single and long terminal seta, strongly and sharply toothed externally and plumose within, and four long plumose setæ attached to the inner margin.

The left leg of the fifth pair in the male, viewed from behind, has the basal joint very large, broader than long, with the inner inferior angle produced downwards as a long, stout, curved process or arm as long as the two remaining joints. The second joint is trapezoidal, shortest within. The third joint is about half as wide at base as the first, is straight without, with a sharp, small tooth at its distal third, and bifid at tip. On the inner margin this joint is at first dilated a little, and then deeply excavated to the narrow tip, to receive the lower end of the left leg, the lower two-thirds of this margin forming the segment of a circle.

The right leg is two-jointed, the first joint twice as broad, enlarged at the lower end, forming an auriculate expansion at its inner inferior angle. The second joint is conical in outline and about two-thirds as long as the first.

The terminal bristles of the rami are very broad and strong in the female, the outer one especially having an extraordinary size and thickness. There is also at the outer angle of each ramus a short, stout spine, that on the left ramus being inflated like the outer bristle. Length .065 in.

The legs of the fifth pair in the female are three-jointed and similar, the basal joint short and broad, the second two and one-half times as long as wide. The leg terminates by four diverging teeth, preceded by two others, one on each side.

Taken in the towing net abundantly in October, 1881, at Grand Traverse bay; also obtained rarely by Mr. B. W. Thomas, from the city water of Chicago."

Occurring in Minnesota, probably in lake Superior.

Sp. 2. **Epischura fluviatilis,** Herrick.

(Plate Q. Figs. 14 and 16.)

Similar to the above but smaller (.04 in.) The females are very similar, though the fifth feet are more elongate and differently spined. The abdomen is perfectly straight and the three caudal setæ are of nearly equal size. The claw is armed with eight teeth, all but the first of which are emarginate. The abdomen of the male is straight, but has a strong process on the left side which bears a movable claw laterally and a small second segment which terminates in two small spines. The fifth foot of the male is peculiar; the inner ramus (or the left foot) lamelliform, one-jointed, with two opposable claws; the right branch is simple and 3-jointed, in form like that of the female. Here we have the most marked difference between the two species. Found in Mulberry creek, Cullman county, Alabama. Although a considerable number were examined no oviferous females were found, while the males contained the spermatophores and can hardly be thought immature, and, as it is in the male that the most marked differences appear, the two species seem certainly distinct.

III.—GENUS TEMORA, Baird.

(Plate H. Figs. 8—16.)

This genus contains several marine forms and two which are found also in streams opening into the sea. The species seem to be as follows: *T. velox*, Lilljeborg, *T. longicornis*, Mueller, (=*T. finmarchia*, Baird, =*Diaptomus longicaudatus*, Lubbock), *T. armata*, Claus, *T. inermis*, Boeck, and *T. affinis*, Poppe. T. clausii, Hoeck, is said by Poppe to be certainly identical with T. velox. Hoeck's figures are incomparably better than any of the preceding, but he seems to have been misled by errors in Lilljeborg. The species described by me before the Academy of Sciences of Minnesota (but still unpublished) as T. gracilis, from the brackish waters bordering the gulf of Mexico, agrees very closely with T. affinis, Poppe. (Abhandlungen v. naturw, Vereine z. Bremen, 1880, p. 55.) This name must therefore take precedence. This species has been found in the Rhine and rivers flowing into the gulf of Mexico, as well as in the marine or brackish waters into which these rivers flow. The occurrence of the genus in American fresh waters, justifies its mention here.

IV.—GENUS OSPHRANTICUM, Forbes.

(=Potamoichetor, Herrick.)

First reported as Potamoichetor before the Minnesota Academy of Sciences in 1879, but owing to a disastrous fire, publication was prevented. Priority probably belongs to Forbes' name, since, although first printed in the tenth annual of this survey, the edition was not distributed till after the August issue of the American Naturalist of 1882, containing the description above alluded to. Forbes says this genus has antennæ 23-jointed; all the specimens we have gathered from Minnesota to Alabama had 24-jointed antennæ. The original description of "Potamoichetor" is appended.

"Cephalothorax six-jointed, distal segments evident; abdomen, in the male, five-jointed, in the female four-jointed; antennæ twenty-four-jointed, the right geniculated as in Centropages (= Ichthyophorbia); first pair of feet with the rami both three-jointed, like the following; feet of the fifth pair, in the female, like the preceding, but with a spine of the joint preceding the terminal one enlarged and divaricated somewhat as in Centropages; in the male, the right with a two-jointed outer ramus, the terminal joint of which is spined and bears near its base a blunt expansion of its inner margin; outer ramus of left foot three-jointed, armed with unequal spines; inner branches smaller, similar, three-jointed; the terminal joint bearing curved spines; ovary and testes as in Diaptomus, with which the mouth parts agree in the main; eyes median, confluent."

Our own experience is that the single species of this genus prefers estuaries of running water. Forbes, however, has taken it from swamps and wayside pools.

Sp. 1. **Osphranticum labronectum**, Forbes.

(Plate Q2. Figs. 1—8 and 13—14.)

Potamoichetor fucosus, HERRICK, Cyclopidæ of Minnesota, etc., p. 224.

"Rather slender, and in size, as well as general appearance, resembling the smaller forms of Diaptomus; antennæ rather stout, reaching but little beyond the feet, appendaged as in Diaptomus, in the male strongly geniculated, but somewhat variously so; the six joints preceding the terminal four are thickened; those preceding the joint or hinge are arcuate on the distal margins; the secondary antennæ are about as in Diaptomus; mandibular palp two-branched, the outer three-jointed, the inner two-jointed; the terminal joint of the shorter branch bearing seven setæ, of the other four, the proximal joint of the former with three stout spines; the maxillæ nearly like Diaptomus; the processes have respectively the following numbers of setæ: the basal plate eight, the small processes at base of posterior branchial appendage one, the appendage itself twelve, terminal portion three groups, first containing nine, the second three, and the third four or five, the upper of the anterior processes two, and the lower three; fifth feet nearly like the others in size; the right in the male having the outer branch but two-jointed by the coalescence of the two outer to form an arcuate and deformed appendage, armed at the end with three stout equal spines; corresponding branch of left foot three-jointed; the terminal joint bearing three unequal spines, each of the preceding joints only one; inner branches similar, three-jointed; terminal joint being short and armed with three short lanceolate setæ and three longer ones, two of which are curved so as to be slightly prehensile; fifth foot of female with both rami three-jointed; inner ramus much smaller; antepenult segment of the outer ramus extending into a large lanceolate process; ova-sac long-ellipsoidal or spherical, reaching nearly to the end of the caudal setæ."

V.—GENUS DIAPTOMUS, Westwood.

The most widely distributed and well-known of fresh water Calanidæ, inhabiting in various species the smallest as well as the largest bodies of standing or sluggishly-flowing fresh water. Apparently a recently formed group whose nearest known ally is the curious Pseudo-diaptomus, found in the gulf of Mexico. The animals of this genus are apparently very susceptible to the influences of the environment, and are consequently extremely variable not only in color but in minor structural points. In America there is a curious fact, which is susceptible of different explanations, one of which was given in the American Naturalist at various times during the year past. The species or varieties fall in pairs, one of which is smaller and less highly differentiated, while the other is greatly enlarged and has the peculiarities emphasized. These sets occur in open and shallow water respectively. The large varieties are, as the rule, restricted to such shallow weedy pools as dry up during summer and freeze solid in winter. The forms intermingle slightly, but there are seasonal differences of greater or less extent.

The body is composed of an elongated thorax, with which the head is united, forming a six-jointed cephalothorax. The abdomen is five-jointed, though in the female these joints are so united as to cause the abdomen to appear three-jointed. The antennæ are twenty-five-jointed, and the right male limb is modified by a coalescing of some of the terminal joints, a thickening of others and the development of certain spines, hooks, and knife-like ridges to form a prehensile organ. The first pair of feet has two-jointed inner rami. The remainder have both rami three-jointed, save the last. This fifth foot is differently formed in the sexes, the inner branch of the fifth foot being one or two-jointed. Terminal joint of the outer ramus of this limb in the female very small or apparently absent, second joint produced to form a stout curved claw. The left foot is reduced in the male, serving, in some species, to affix the spermatophore to the body of the female, while the abdomen is held by the right foot. The last segment of the thorax has one or two sharp spines below. The spermatophore, or sperm case, is a long tube with coagulating expansive lining, which forces out its contents on exposure to the water. The colors are frequently brilliant.

Three or four species of this genus are known in Europe, the first being Diaptomus castor which seems universally distributed. It can hardly be doubted that the six forms mentioned below belong among the varieties of this species; yet these forms can be distinguished very well, and are deserving of distinct names. Two other forms are nearest D. gracilis of Sars, but sufficiently distinct. These stand related as do the pairs of the other section, and can not be readily distinguished.

The following is the most convenient arrangement of the genus I have been able to devise.

KEY TO THE GENUS DIAPTOMUS.

I. Form robust; right antenna of the male with a hook, much swollen anterior to the geniculating joint.

A. Head not greatly dilated.

*** Last segment of thorax prolonged into a sharp-spined angle or tooth.**

† With but one tooth (?).

1. *D. castor*, Jurine.

†† With two teeth.

‡ Length under 3 mm.

§ Inner rami of fifth feet in the female 1-jointed.

2. *D. sanguineus*, Forbes.

4. *D. armatus*, Herrick.

§§ Inner rami 2-jointed.

3. *D. minnetonka*, Herrick.

‡‡ Length over 3 mm.

5. *D. stagnalis*, Forbes.

** Last segment of the thorax more or less united with the previous one, bearing very small spines.

6. *D. longicornis*, Herrick.

(a) Length under 2 mm.

var. leptopus, Forbes.

(b) Length over 2 mm.

var. similis, Herrick.

B. Head enlarged.

7. *D. laticeps*, Sars.

II. Form slender, elongate; head divided into two portions; antennæ long, slightly altered in the male.

A. Antenna of male with a hook.

8. *D. gracilis*, Sars.

B. Antenna of male without a hook.

9. *D. pallidus*, Herrick.

(a) Antennæ much longer than the body, inner rami of fifth pair of feet in the male 1-jointed.

var. pallidus, Herrick.

(b) Antennæ little longer than the body, inner ramus of fifth feet bi-articulate.

var. sicilis, Forbes.

Sp. 1. **Diaptomus castor,** Jurine. [Sars.]

"Corporis forma sat robusta. Cephalothorax in femina postice parum antice vero magis attenuatus, angulis laminarum segmenti ultimi obtusis. Segmentum 1-mum abdominale absque mucrone laterali. Rami caudales brevissimi segmento antecedente vix longiores setis crassis et brevibus. Antennæ 1-mi paris mediocris longitudinis reflexæ segmentum 3-tium abdominale vix superantes, animali natante leviter arcuatæ adque latera vergentes; articulus ultimus [?] antennæ dextræ maris in hamulum exiens acuminatum. Ramus antennarum 2-di paris exterior interiore parum modo longior, articulo ultimo quam antecedentibus 5 junctis breviore. Articulus ultimus pedum 5-ti paris in femina perrudimentaris tuberculum solum minimum aculeo uno parvo instructum formans; unguis intus curvatus maximus validusque; appendix interna indistincte bi-articulata longitudinem articuli 3-ti-superans; unguis terminalis pedis dextri maris longissimus leviterque arcuatus. Saccus oviferus parva et multa continet ova colore castaneo. Color animalis variat ex fulvo, cæruleo vel rubro. Longit. fem. interdum fere 3 mm. Habitat in aquis stagnantibus."

The description quoted above from Sars does not agree with Claus' or Brady's account of the same species. From what Brady says of the English Diaptomi one would conclude that the same variations occur there as here. D. westwoodii, which he unites with D. castor, is certainly as different from that species as our D. stagnalis is from D. sanguineus. An actual comparison of specimens will be necessary to clearly define the relation of the American and European species.

Sp. 2. **Diaptomus sanguineus,** Forbes.

(Plate Q. Fig. 12.)

A species found with us in stagnating pools in early spring, frequently following D. stagnalis and giving place to D. leptopus. It prefers pools less foul than those affected by the latter, though not rarely found with it temporarily. The species is quite variable, and the variations are in directions suggestive of other species. Measurements taken of specimens from a gathering from two pools, one being more stagnant than the other, showed the following results:—males from the less stagnant 1.7 mm.; males from the other pool 2.0 mm.; a difference of 0.3 mm. (Males of D. stagnalis from the latter gathering measured 3.4 mm., while the females of that species vary between 3.8—3.9 mm.) Females measure about 1.8 mm. on an average, of which 1.3 mm. is the length of the thorax. Such individuals have antennæ 1.7 mm. long. The greatest width is anterior to the middle, being about 0.5 mm.

This species differs from D. stagnalis of which, in most respects, is a miniature, by the long antennæ, short abdomen and peculiar armature of the fifth feet.

In the female the fifth foot is about 0.5 mm. long, and the outer ramus has two small spines on the terminal joint, while the segment before the last has a powerful toothed claw. The inner ramus is not evidently two-jointed. The first abdominal segment is spurred on either side. The last thoracic segment extends into a strong angle which bears a heavy spine terminally, and a smaller spine dorsally. On the dorsal median line is a protuberance or "hump" on this segment. In the male the outer ramus of the right foot of fifth pair is long, and terminates in a powerful curved, toothed claw. The inner ramus is small and narrowed toward the end; on the outside of the segment from which it springs is a blunt spine, which is nearly as large as the ramus itself, and has been mistaken for it. The left foot is very fleshy and its inner ramus very rudimentary. The color is brilliant red or purple but variable. Found in the southern states in autumn.

Sp. 3. **Diaptomus minnetonka,** (Sp. n.)

(Plate Q. Figs. 8—10.)

A small species, smaller than either D. longicornis or D. sanguineus, was gathered in a pool bordering lake Minnetonka, which contained also D. longicornis. It unites the characteristics of both species. The antennæ reach beyond the stylets, the color is dark, the margins of the last segment of the thorax is rather strongly spined, very much as in D. sanguineus. The fifth feet of the female resemble very much those of D. leptopus, but the first segment of the abdomen has a strong spine. The fifth foot of male resembles that of D. sanguineus more than that of leptopus. This species was seen but once, and no measurements can be given save that of the male which was 1.4 mm.

Sp. 4. **Diaptomus armatus**, Herrick.

Is founded upon an imperfectly known form in which the antennæ do not reach the end of the abdomen; the thickened part of the male antennæ short; the antenna armed as in D. sanguineus; the terminal claw of the fifth foot of the male with a tooth near the base; the claw being nearly as long as the ramus.

Sp. 5. **Diaptomus stagnalis**, Forbes.

(Plate Q. Figs. 11 and 13.)

D. giganteus, HERRICK.

The largest species of the genus and, not improbably, too close to D. westwoodii, Lubbock. The general characters are like those of D. sanguineus, but the form is much more robust and the antennæ only moderately exceed the thorax. The proportions may be gathered from the measurements given. In the female the length of thorax is 2.5 mm.; abdomen 1.2 mm.; antennæ 2.3 mm.; stylets 0.1 mm. The caudal stylets are as broad as long, or nearly so. The last thoracic segment extends into an irregular process 0.1 mm. long, bearing a spine dorsally. The first abdominal segment is spurred on either side. The fifth feet in the female have two-jointed inner rami. The terminal segment of the outer ramus is more than ordinarily distinct, while the claw is biserrate. The right foot of the fifth pair in the male is very long, its claw being strongly toothed. On the inside of the second joint from the base is a disc-like appendage peculiar to this species. The left foot is short. The longer ramus is three-jointed, but the terminal joint is a mere curved spine, opposing a spine from the penultimate segment, which is covered with minute spines or teeth. The basal joint of the ramus has a bristly protuberance distally. The inner ramus is marked with oblique ridges. The right antenna has a powerful hooked spine on the antepenult segment, the two segments beyond which coalesce in maturity as in the other related species. For measurements see above. Color deep opaque red or purple. Appearing in early spring as soon as the ice is melted from the pools which it inhabits. In the south it occurs in autumn. The name above given seems to have the priority, although this species was figured and described at about the same time in the annual of this survey.

Sp. 6. **Diaptomus longicornis,** Herrick

This name was applied somewhat loosely, the description given being incomplete, but re-examination of types shows it to belong unquestionably to the form since described as *D. leptopus.* In our state we have found another variety, in general, almost identical with the type specimens, but nearly twice as large. It is now proposed to extend the significance of this name so as to include both varieties, which will undoubtedly be found connected by intermediate forms, thus retaining the name given by Forbes for the variety to which it in particular applies.

(a) **var. leptopus,** Forbes.

This species is the commonest member of the genus in small lakes and clear pools. It is tolerably constant in coloration, but varies somewhat in size. The original description is insufficient to identify the species definitely, but taken in connection with the figure and the measurement, could hardly be refered to either of the other American forms. This species is characterized by the very compact thorax, the margin of the last segment of which has two very minute spines; and by the form of the fifth feet. The antennæ reach nearly to the end of the caudal setæ, while in the next they fall short of the length of the stylets. The outer spines of the swimming feet are denticulate on the outer margin and setose within. The fifth feet of the female are compact, the inner ramus is more or less obviously two-jointed; the third joint of the outer ramus is almost obsolete and has two short spines; the claw of second joint is strongly denticulate. The male fifth foot has a rather long inner ramus which is very imperfectly two-jointed; the left foot is rather long; the claw of the right foot is armed with crenulate teeth. Length 1.5—1.7 mm., without setæ. The body, which is broadest anterior to the middle, is bluish; the tips of the antennæ are deep purple. The eggs are not as numerous as in the next.

(b) var. similis. (Var. n.)

(Plate Q. Figs. 5—7.)

This form is twice as large as D. leptopus, but otherwise scarcely distinguishable. It occurs in autumn (and spring?) in shallow pools, which can but be frozen solid. The following differences are the only points yet noticed. Females of both of the species were placed side by side upon a slide and examined. D. leptopus measured 2.4 mm., exclusive of caudal setæ; the antennæ reached hardly to the base of the stylets; the eggs measured 0.12 mm., while those of D. longicornis measured 0.8 mm.; the egg-sac measured 0.8 mm., while that of longicornis was 0.5 mm. A few other minute differences were noticed, but the general form and color was identical. The peculiar doubling of the edge of the last segment is characteristic of these two forms; each has a small spine on either side of the abdomen. The base of the inner ramus of left foot of fifth pair of the male has a double series of spines.

Sp. 7. **Diaptomus laticeps,** Sars.

"Cephalothorax antice dilatatus, latidudine maxima in parte antica capitis sita, postice sensim attenuatus, segmento ultimo feminæ ad latera parum extante angulis lateralibus acuminatis. Segmentum 1-mum abdominale feminæ antice latum mucrone brevi laterali armatum, postice sensim attenuatum. Rami caudales sat magni segmenta antecentia 2 juncta longitudine æquantes setis brevissimis et robustis instructi. Antennæ 1-mi paris feminæ longitudinem corporis æquantes, animali natante rectæ et quam in D. gracili adhuc magis postice vergentes; articulus antepenultimus antennæ dextræ maris hamulo armatus. Ramus exterior antennarum 2-di paris interiore multo longior articulo ultimo longitudinem articulorum anticedentium 5 æquante. Pedum 5-ti paris feminæ articulus ultimus parvus, cylindricus, non vero tam rudimentaris quam in D. castore, aculeo uno brevi apicali instructus; appendix interna ne tertiam quidem longitudinis articuli 3-ti partem æquans et uniarticulata; pedis dextri maris articulus 3-tius extrorsum aculeo forti armatus, ungue terminali valde flexuoso et subsigmoides; sinister aculeis duobus rectis terminatus. Saccus oviferus sat multa continet ova. Color pleurumque læte cæruleus, interdum pallidior, albescens. Longit. feminæ circit. 1½ mm."

Sp. 8. **Diaptomus gracilis,** Sars.

"Corpus quam in D. castore gracilius, cephalothorace et antice et postice attenuato, latitudine maxima in medio sita. Anguli laminarum segmenti ultimi thoracalis feminæ in mucrones tenues et acuminatos producti, et mucrone simili sat magno segmentum 1-mum abdominale utrinque armatus est. Rami abdominales breves setis in femina valde divergentibus. Antennæ 1-mi paris feminæ perlongæ et tenues, longitudinem totius animalis longe superantes, animali natanti rectæ et aliquantum postice vergentes; articulus antepenultimus antennæ dextræ maris hamulo longior, articulo ultimo rami dimidium longitudinem æquante. Pedum 5-ti paris feminæ articulus ultimus distinctus, quadratus aculeis duobus apicalibus quorum interior apicem fere unguis articuli penultimi attingit instructus; appendix interna articulo 3-tio brevior; unguis terminalis pedis dextri maris apicem versus valde curvatus. Saccus oviferus semper ova continet paucissima et magna regulariterque distributa. Animal pleurumque pellucidum colore albido, interdum vero facia transversa lata coloris fusci saturati in medio cephalothorace ornatum. Longit. feminæ parum supra 1 mm."

The two forms following are sufficiently distinct from the above and form a closer link with the marine Calanidæ. It is doubtful if any absolute line of demarkation exists between these varieties, although they are here distinguished.

Sp. 9. **Diaptomus pallidus**, Herrick.

(Plate Q. Fig. 17.)

Length 1.20 mm.; length of antennæ 1.35 mm. Colorless. Head separated by a suture into two parts; form very slender. Antennæ with elongated setæ, which are very plumose. The right male antenna has no hook. The inner rami of the fifth feet are one-jointed in both sexes. Left foot of the fifth pair of the male of peculiar form (see plate Q, fig. 17, for an extreme instance). Entire Mississippi valley.

var. sicilis, Forbes.

(Plate Q. Fig. 18.)

Like the above, but larger. Length 1.45 mm. Length of antennæ 1.5 mm. Inner ramus of male feet of fifth pair two-jointed, those of the female one-jointed. The form of feet varies a little from the above. This species has been but once encountered in Minnesota, the previous species occurring abundantly in our larger lakes.

D. kentuckyensis, Chambers, is referable to one of the above species, probably D. longicornis.

For a full account of synonymy see Rehberg, *Beitrag z. Kenn. d. freileb. Suesswasser Copepoden*, p. 552.

VI.—GENUS LIMNOCALANUS, Sars.

Cephalothorax 6-jointed, slender; abdomen in the female 3-jointed, in the male 5-jointed. Antennæ shorter than the body, 25-jointed. Caudal stylets long. Feet of the four anterior pairs with both rami 3-jointed; external ramus of the fifth foot in the female 3-jointed, second joint produced into a spine; inner rami 3-jointed in both sexes and like those of the previous pairs; external rami 2-jointed in the male, the right and left dissimilar.

Sp. 1. Limnocalanus macrurus, Sars.

A species similar to L. macrurus has been found in lake Michigan, and probably occurs also in this state in lake Superior. We can do no better than quote Sars' description.

> "Corpus gracile et angustatum. Cephalothorax supra visus elongato ovatus, latitudine maxima in medio sita antice et postice æqualiter attenuatus. Caput annulum unicum præbens, a latere visum parte antica altiore et convexa sinu distincto a posteriore disjuncta, margine antico oblique descendente. Segmentum ultimum thoracis parvum neque ad latera extans in femina et mare simile. Abdomen sub-cylindricum thorace longius. Rami caudales valde elongati et angustati tertium longitudinis abdominis partem superantes, supra et ad latera spinulis vel pilis brevibus obsiti, intus ciliati, setis 5 majoribus uniarticulatis et ciliatis, quarum 2-da ab interiore numerata omnium longissima ceteræque extus graduatim longitundine decrescentes, exteriore ceteris minore absque apice sat remota; seta adest præterea alia intus adfixa ut in generibus antecedentibus tenuissima et simplex. Frons a latere visa obtuse acuminata appendicibus tentaculiformibus duabus perbrevibus instructa. Antennæ 1-mi paris reflexæ segmentum penultimum abdominis minime attingentes, articulo ultimo setis 5, quarum posteriores 2 longissimæ, instructo, articulis antecedentibus 3 setæ simili postice vergente præditis; dextra maris articulatione inter articulum 18-mum et 19-mum geniculans. Antennarum 2-di paris ramus exterior interiore et longior et latior, 7-articulatus, articulo 2-do omnium maximo, sequentibus 4 minimis junctis articulo ultimo brevioribus setisque longissimis instructis. Mandibulæ ad extremitatem inferiorem in dentes exeuntes 9, quorum exteriores 2 ceteris majores, interiores 2 tenues et setiferes sunt; palpus longus et angustatus 3-articulatus, articulis ultimis 2 brevissimis, ramo exteriore, vel appendice branchiale, parvo. Maxillæ 1-mi paris eadem fere structura ac in Diaptomo. Maxillæ 2-di paris validissimæ 8-articulatæ, articulis ultimis 5 in ungues exeuntibus longissimos et fortissimos margine altero sparsim pilosos, ad apicem falcatum vero nudos vel aculeis persubtile et dense obsitos; 3-tii paris [Maxillipedes] valde elongatæ et angustatæ antice vergentes articulis 7 setis pleurumque longis præditis compositæ. Pedes omnes biramosi natatorii, ultimo pari in mare bi-articulatus in pede dextre et sinistro dissimilis, articulo ultimo in illo brevi et robusto ad apicem quasi truncato dentibusque 3 parvis et obtusis armato intus vero in aculeum magnum et validum excurrente, in hoc valde elongato extus et ad apicem aculeato intus vero nudo. Oculus unicus propius marginem inferiorem capitis situs. Animal quamquam pellucidissimus et fere omnino hyalinum, facile tamen accumulatione in thorace sat magna liquoris oleosi læte fulvo-rubide colorati se prodit. Longit. circit. 2½ mm."

FAMILY CYCLOPIDÆ.

Contains five genera, viz: *Thorellia*, *Cyclops*, *Oithona*, *Lophophorus* and *Cyclopina*; passing, by the genera *Misophria* and *Pseudo-cyclops*, into the *Calanidæ* or marine copepods. The affinities of these little known genera need further study, as they are very interesting, the question being still open in how far the cyclopoid forms are altered by adaptation to saline habitat, if such an adaptation takes place at all.

Cephalothorax ovate and usually much more robust than the abdomen; anterior antennæ seldom longer than the cephalothorax, those of the male alike on both sides and modified for the purpose of clasping; posterior antennæ unbranched (i. e. palpus wanting);

palps of mandibles and maxillæ usually well-developed; foot-jaws mostly less developed than in *Calanidæ*; first four pairs of feet as in *Calanidæ*, fifth pair rudimentary, alike in both sexes, and usually one- or two-jointed; ovisacs two.

The circulatory system of this family is partly lacunal and has been thought to be entirely so in the genus Cyclops. closer observation, however, shows that there is something like an imperfect central organ at the point occupied by the heart of higher Copepods. This was figured in my previous report, plate V, fig. 1, but no mention was made of the discovery. It has since been verified. The apparatus referred to is a modification of that described under Canthocamptus. In the second thoracic segment there is a set of swaying membranes which constitute a valvular apparatus, chiefly moved by the action of the stomach.

GENUS CYCLOPS.

The sole representative of the genera of the Cyclopidæ here treated is the best known of the Copepoda. Every one is familiar with the "common cyclops," but few realize how many are the species included under this name. An attempt is here made to enable the student to recognize the more obvious distinctions upon which the genus is subdivided and to identify such of the species as seem valid and at the same time recognizable without recondite study of development. Without attempting a complete elucidation of the synonymy, which is practically an impossibility, a proximate classification of all the species known to me is attempted. Thirty sufficiently well marked species are enumerated, and the position of a number more is indicated.

Antennæ 18-jointed.

Sp. 1. Cyclops elongatus, Claus.

This species, cited hitherto, apparently, by but one other author than Claus, is distinguished from the C. pulchellus group by the 18-jointed antennæ, which are hardly longer than the first thoracic segment. The caudal stylets are longer than the two preceeding abdominal segments, and bear rather short setæ. C. elongatus has been found by Cragin near Cambridge. That this species, found thus far by but a single author in Europe, appears in America, may serve as a warning not to decide too hastily from its habitat that a copepod is new.

Antennæ 17-jointed.

I.—Fifth Foot 1-jointed.

Sp. 2. Cyclops ater, Herrick.

(Plate Q^2. Figs. 9—12.)

This is our most striking species and loves the clearer flowing waters. The thorax is broadly oval and, usually, of a deep color. Antennæ as long as the cephalothorax (1.2 mm.), slender, and tapering toward the end; formula[1] –⏓⏑–––⏑–⏑⏑⏑⏓⏓⏑–––; last three joints rather short, the last joint furnished with an unserrated knife-like ridge as in C. tenuicornis; maxillipedes rather large; fifth foot one-jointed, armed with three subequal spines; abdomen rather short, last segment especially short; stylets of moderate length; setæ rather short, internal seta much longer than the outer, lateral seta near the end of the stylet; eggs pale. Color deep blue or gray. Length 2.1 mm. The young can be recognized without a glass by the band of deep color which crosses the thorax in the middle.

Collected near Minneapolis, in "Mud lake" and Bassett's creek.

This species has been collected in different parts of the Mississippi valley from Alabama to Minnesota, but is nowhere very abundant, being but rather more so southwardly.

II.—Fifth Foot 2-jointed.

A.—*First joint of fifth foot very broad.*

Sp. 3. Cyclops viridis, Jurine. (Rehberg.)

(var. a.)
C. vulgaris, KOCH, FISCHER, SARS.
C. brevicornis, CLAUS, LUBBOCK, HELLER, FRIC, HOEK.
C. viridis, CRAGIN.
(var. b.)
C. gigas, CLAUS, SARS, FRIC, BRADY.
C. ingens, HERRICK.

The American form is usually somewhat different from the C. gigas, but the stage prior to maturity is like that figured by Brady. Observations made over a considerable territory and for a period of several years led me to the conclusion expressed by Rehberg (Abhandl. naturwiss. Vereine zu Bremen. Bd. vii, 1. Heft. p. 62) that C. gigas is but a greatly enlarged form of C. brevicornis. See also American Naturalist, May, 1883, p. 499, where I have expressed a similar opinion regarding the American form.

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[1] The accent marks are used to signify that joints represented by them (counting from base) are either long —, short ⏑ or medium ⏓.

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A part of the original description of C. ingens is here given.

Thorax large; abdomen rather slender; stylets slender, with the lateral seta well towards the end; second and third setæ alone long, weakly pectinate; last joint but one of abdomen sometimes toothed along the distal, under margin; jaws with large teeth; antennæ very short, not reaching to the base of the first cephalothoracic segment; formula –⏓⏑ –⏓⏑–⏑⏑⏑⏑⏑⏑⏑⏑⏓⏓; fifth foot two-jointed, the proximal joint very broad with a strong spine; second joint cylindrical with a long seta and a very short spine near the end; operculum vulvæ somewhat heart-shaped; egg-sacs oval-elongated, reaching beyond the end of abdomen; length 4 mm., including stylets and setæ.

Sp. 4. **Cyclops leuckartii**, Claus.

? *C. crassus*, FISCHER.

Is said to be elongated and slender; the antennæ are nearly as long as the first three segments. The fifth foot is like the smaller forms of the above, but the second joint has only one spine. The proportions of the caudal setæ are very much as in the above.

Rehberg denies that Sars' identification of this species so briefly described by Claus is correct; his description is therefore copied. Sars refers also with a query to C. obsoletus, Koch.

"Cephalothorax ovatus antice sat attenuatus, fronte leviter truncata, segmento ultimo parvo vixque ad latera exstante. Segmentum abdominale 1-mum sub-cylindricum antice quam postice parum latius. Rami caudalis brevisculi longitudinem segmentorum antecedentium duorum non attingentes setis apicalibus sat longis, externa furcæ longitudinem æquante dimidiamque interni, intermediarum interiore altera aliquanto longiore longitudinem abdominis fere æquante; seta marginis exterioris ab apice sat remota. Antennæ 1-mi paris 17-articulatæ, longæ et apicem versus attenuatæ, reflexæ segmentum 4-tum corporis fere attingentes, 2-di paris quam in speciebus ceteris longiores. Maxillarum 2-di paris margo posticus subtilissime crenulatus. Pedes 5-ti paris bi-articulati, articulo ultimo bisetoso. Rami pedum natatoriorum omnes 3-articulati; articulus rami exterioris intus setis 3, extus aculeis 2 instructus. Lamina partes basales pedum 4-ti paris conjugens utrinque in processum acuminatum exit. Rami interioris articulus ultimus insolite modo in longitudinem extensus in pedibus 4-ti paris aculeis apicalibus 2 subæqualibus armatus. Sacci oviferi rotunda to-ovati ab abdomine sat exstantes. Longit. parum supra 1 mm."

Sp. 5. **Cyclops lacustris**, Sars.

Cephalothorax sub-ovate, truncate in front. Abdomen nearly of equal width; caudal stylets longer than the last two segments of the abdomen terminal; setæ of moderate size, inner three times as long as outer, internal pair nearly equal. Antennæ as long as first two segments. The inner ramus of fourth foot has the exterior thorn very small. The second joint of the fifth foot is small and the external thorn very small. Length 1.5 mm.

Not seen in America.

B.—First joint of fifth foot of moderate size.

(a) Terminal segment of fifth foot with one long seta and a short thorn.

These small species pass into the above group and constitute one of the most difficult groups of the genus. The distinctions offered are very small and specific variation considerable.

Sp. 6. Cyclops strenuus, Fischer.

? *C. pictus*, KOCH.
C. brevicaudatus, CLAUS, LUBBOCK, HELLER, FRIC.
C. strenuus, SARS, BRADY.

Antennæ reaching about to the end of the third segment; caudal stylets slender, three times as long as the last segment; the outer of the caudal setæ shortest. The third seta is over once and one half the length of the stylet.

Sp. 7. Cyclops lucidulus, Koch.

C. lucidulus SARS.
C. furcifer, CLAUS.
C. vernalis, FISCHER.

This species is given on the authority of Rehberg. Claus considered C. furcifer a large variety of the above species.

The antennæ are as long as the first segment; the fifth foot is peculiar in form, with the second joint armed with a spine and a hook; length 1.3 mm.

Neither this nor the previous species is known in America.*

Sp. 8. Cyclops robustus, Sars.

Antennæ shorter than first segment, thick. Body depressed, first segment broad and rounded anteriorly, the others spreading; caudal stylets nearly parallel, long; inner median seta much the longer, external setæ very short. Terminal joint of outer rami with three spines externally and four setæ internally. Length 1.3 mm. I know nothing of this species save the description of Sars, a part of which is quoted above.

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*C. pulchellus, Brady is not C. pulchellus, Koch, and may be the above species.

Sp. 9. Cyclops parcus, Henick.

(Plate R. Fig. 22.)

Cyclops parcus, HERRICK, Crustacea of Minnesota, p. 229; Plate VI., Figs. 12—15.

In form and general appearance greatly resembling Cyclops thomasi, which it nearly equals in size. The chief differences are found in the length of the caudal stylets and antennæ and in the form of the fifth foot. The antennæ are shorter than, or about as long as, the first thoracic segment. The formula expressing the length of the joints corresponds with that for C. thomasi. The antennules are shortish. The labrum is rather narrow, projecting below into obtuse angles, the middle of the lower face being occupied with nine rather small teeth. The terminal joint of the larger branch of the maxilliped bears four hairs. The second joint has a moderately large dactyl, the movable finger of which is small and sparsely spiny, the immovable finger is ornamented by an oblique series of blunt prominences and a small seta at its base. The first pair of feet has two terminal and two interior setæ and two external spines on the ultimate joint of the outer ramus, while the corresponding joint of the inner ramus bears one inner seta and large spine and three outer setæ. The fourth foot has, in the first case, two outer spines, a terminal spine and seta and three internal setæ, and, in the second, one external seta, two subequal terminal spines and two internal setæ. The fifth foot is two-jointed, bearing on the short basal joint a moderate seta and on the larger second joint a considerable seta and a small oval spine on its side. The caudal stylets are short and the lateral seta is near the end (about 1·5). The outer seta is but three-fourths the length of the inner. The inner of the median setæ is considerably longer than the outer. The shape of the operculum of the female is very characteristic, it being nearly oval. The last two joints of the thorax are acute. The entire length is about 1.5 mm.

Sp. 10. Cyclops brevispinosus. (Sp. n.)

(Plate S. Figs. 7—11.)

The form for which this name is proposed takes the place of the above in the larger lakes. It appears to be but a modified condition of the above species, from which it differs in its slender form and especially in the very slender caudal stylets. The outer caudal seta is reduced to a short ciliate thorn. The fourth foot is also modified by the great enlargement of the spines and the reduction of the setæ. The number of the setæ is the same, but they are differently disposed. The form of the operculum vulvæ is also slightly different.

(?) Sp. 11. Cyclops uniangulatus, Cragin.

Cyclops uniangulatus, CRAGIN. A Contribution to the History of Fresh-water Copepoda, p. 6.

Cragin was not conversant with the description of C. parcus, with which his description agrees save in one point. It differs from C. parcus in having three inner setæ on the terminal joint of the outer ramus of the first foot. It would be officious to suggest a possible oversight here, but C. parcus has only two in type specimens (though in all this group the corresponding ramus of the *second foot* has three setæ), so that at present the two must be kept distinct.

Sp. 12. Cyclops scutifer, Sars.

Not having identified this and the following species it will be best to quote the descriptions.

C. strenuo affinis. Cephalothorax sat elongatus, segmentis ultimis duobus in femina ad latere valde prominentibus inque processos exeuntibus laminares et hyalinos utrinque inter se contiguos, quare thoracis pars posterior tamquam clypeo fornicato quadrangulari obtecta esse videtur. Segmentum 1-mum abdominale ad basin valde dilatatum latitudine quam ad marginem posteriorem duplo majore. Rami caudales segmentes antecedentibus duobus junctis parum longiores, introrsum ciliati, setis apicalibus brevissimis, intermediarum interiore ceteris multo longiore. Antennæ 1-mi paris 17-articulatæ, reflexæ segmentum 2-dum corporis superantes setis plurumque longis obsitæ. Pedum structura eidem in C. strenuo similis. Articulus scilicet ultimus rami exterioris pedum natatoriorum setis 5 instructus in paribus anterioribus duobus 3, in sequentibus duobus 2 modo aculeis marginis exterioriis armatus; aculeorum apicalium rami interiores pedum 4-ti paris exterior brevis et rudimentaris. Pedum 5-ti paris articulus ultimus sat magnus articulo basali parum minor extrorsum sparsim pilosus introrsum aculeo armatus ciliato setaque longa terminali. Sacci oviferi parvi globosi abdomen magna ex parte obtegentes. Longit. circit. 1½ mm.

Sp. 13. Cyclops abyssorum, Sars.

C. strenuo et scutifero sat affinis. Cephalothorax ovatus antice obtuse truncatus, segmentis parum ad latera extantibus. Rami caudales longi et tenues satisque divergentes, longitudinem segmentorum antecedentium 3 superantes, setis apicalibus longioribus intermediarum interiore duplam longitudinem furcæ superante, exteriore quam illa parum breviore. Antennæ 1-mi paris 17-articulatæ longæ et fere rectæ distincte postici

vergentes, reflexæ segmentum 3-tium corporis fere attingentes. Pedum natatoriorum structura fere eadem ac in speciebus antecedentibus; aculeorum apicalium rami interioris pedum 4-ti paris exterior dimidiam fere interioris attingens longitudine. Pedum 5-ti paris articulus basalis minimus ultimo multo brevior parumque latior. Sacci oviferi mediocres rotundato-ovales abdominique appressi. Longit. circit. 2 mm.

(b) Terminal segment of fifth foot with two rather long setæ.

* External and internal caudal setæ not extremely short.

Sp. 14. Cyclops oithonoides, Sars.

(Plate S. Figs. 2—6.)

? *C. hyalinus*, REHBERG.
? *C. tenuissimus*, HERRICK.

This most interesting species occurs under peculiar circumstances. It is perhaps the rarest member of the genus and seems, beyond a doubt, nocturnal in its habits. It was first found by Sars in saline water and named, on account of its slender form, from the marine Oithona. A similar species which, though about half as large, is hardly distinct, was found by Rehberg near Bremen. Rehberg mentions particularly that it was found oftener at night than during the day. In America a similar species was described from near Paducah, Ky., under the name C. tenuissimus; but the possibility of identity with the Scandinavian species seemed excluded by the habitat. A gathering taken at night from one of the lakes near Minneapolis contained a few specimens of similar characters, and there no longer seems to be a doubt of the identity or very close relation between these forms.

The antennæ are longer than described for C. tenuissimus, nearly equalling the thorax. The last joint of the antennæ is short, but the toothed character was not noted. The fifth feet are small, the spines are very long and slender. The margins of the abdominal segments are irregularly toothed. The species will be confused with no other. It is marked with blue in spots. Length 0. 5—1. mm.

Sp. 15. Cyclops simplex, Poggenpol.

Cyclops Leeuwenhoekii, HOEK (fide Rehberg).

This species is of more compact form than the last, which it resembles in the form of the caudal stylets and the fifth foot. The antennæ are nearly as long as the thorax, the last two joints being elongate and having a knife-like ridge which has at the end teeth like those figured in C. tenuissimus. Length 1.—2. mm.

** The two median setæ much longer than the external.

The species of this section are the most perplexing of the genus. The best that I can now do is to indicate the relations of the nominal species and express the conviction that most are of varietal value simply.

Sp. 16. Cyclops pulchellus, Koch.

C. bicuspidatus, CLAUS.

† Terminal joint of outer ramus of feet with two spines outwardly.

16 a. *C. thomasi*, Forbes.

16 b. *C navus*, Herrick.

†† With three spines.

16 c. *C. bisetosus*, Rehberg.

= *C. bicuspidatus*, Sars.

= (?) *C. insectus*, Forbes.

There are at least three well marked varieties in America, which may probably rank as species and have been ranked as such by Forbes. I give verbatim Forbes' description.

(16a) Cyclops thomasi, Forbes.

(Plate U. Figs. 4, 5, 7 and 8.)

"Elongate, slender, broadest in front and tapering backward, antennæ 17-jointed, reaching the middle of the third segment.

The first abdominal segment in the female is broad in front and slightly emarginate on each side before the anterior angles, and the last segment has a terminal circlet of small spines. The rami of the furca are more than half as long as the abdomen, and each bears two short rows of transverse spinules outside, one at the anterior the other at the posterior third. With the latter a spine occurs about as long as the outer terminal seta. The inner seta at the tip of the ramus is about half the length of the furca, the outer still shorter. The inner median seta is as long as the abdomen and furca, and the outer about half as long.

In the outer ramus of the first pair of legs the terminal joint has one spine and two setæ at the tip, one spine on the outer margin and two setæ within.

In the second, third and fourth pairs the last joint has one spine and one seta at tip, two spines externally and two setæ within. The inner rami of the second and third pairs terminate in one spine and one seta, that of the fourth pair in two spines, the inner of which is only half as long as the other.

The legs of the fifth pair are two-jointed, with the basal joint quadrate, broad, and bearing one long spine. The second joint is narrow and longer, parallel and truncate, with one terminal spine about equal to the preceding, and one about half that length.

From *C. bicuspidatus*, Claus, this species may be distinguished by the armature of the outer ramus of the first pair of legs, and from *C. bisetosus*, Rehberg, by the armature of the outer rami of the other legs.

It shares with *Diaptomus sicilis* the responsibility of affording to the young white-fish their earliest food."

(16 c) **Cyclops insectus,** Forbes.

(Plate U. Fig. 9.)

"Closely allied to the preceding, but more robust in all its parts, and with the second cephalothoracic segment widest. The abdominal segments are all bordered with spinules posteriorly. The two median caudal setæ are much more nearly equal than in *thomasi*, the outer and the inner are very short, but longer than in that species. The inner in our specimens is longer than the outer —the reverse being the case in *bicuspidatus* as described by Claus.

"The legs are armed nearly as in *thomasi*, but the last joint of the outer ramus of the first pair has two spines externally besides the one at the tip, and the terminal spines on the last segment of the inner ramus of the fourth pair of legs are about equal."

Both forms probably occur in Minnesota, though the second has been seen but once, and the identification lacks confirmation. The differences between the two are almost exactly those prevailing between C. bicuspidatus (= pulchellus) and C. bisetosus, Reh., if I correctly understand Sars. Claus' description does not agree with that of Sars. Further study of the European types will be necessary before a satisfactory settlement can be reached.

(16 b) **Cyclops navus,** Herrick.

Cyclops navus, HERRICK, Copepoda of Minnesota, p. 279.

This name, proposed at nearly the same time as C. thomasi, applies to a very closely related form which I can but regard as a variety of that species. It seems constant in its differential characters in given localities, but we are now familiar enough with the fact that changed conditions in the water occasion changes in forms in the copepods.

This form inhabits shallow pools. It is larger than C. thomasi, has much shorter stylets and differently proportioned antennæ, etc.

Length 1.5 mm. Thorax 0.9 mm.; abdomen 0.6 mm.; stylets 0.14 mm.; last two abdominal segments 0.16 mm.; antennæ 0.7 mm.; first segment of body 0.5 mm. The basal segment of the antennæ is long and ornamented with several transverse series of spines, the last two segments are equal and longer than the preceding. The armature of the first and fourth feet is identical with C. thomasi, as is the form of the female openings and the fifth feet. The form of the first feet, caudal stylets and other details were correctly figured on plate V of the Cyclopidæ of Minnesota.

Specimens of Cyclops pulchellus (thomasi) were obtained from a cistern which is supplied solely by rain-water. The eggs must have been introduced in ice which had been placed in the cistern at least a year previously. The cistern is entirely dark, so that these animals must have been deprived of light for many generations. The general color was of course very white; the eye spots were pale, but present with some pigment and the lenses. No noticeable alteration in form had resulted.

(c) Terminal segment of fifth foot with three setæ.

Sp. 17. **Cyclops tenuicornis,** Claus.

(Plate R. Fig. 16.)

var. a. **Knife-like ridge upon the antennæ smooth.**
  C. albidus, JURINE,
  C. quadricornis, var. b, BAIRD.
  C. tenuicornis, SARS, LUBBOCK, HELLER, FRIC, ULJANIN, HOEK, BRADY, HERRICK.
  C. clausii, POGGENPOL.
  C. annulicornis, SARS.
var. b. **Knife-like ridge of antennæ toothed.**
  C. obesicornis, TEMPLETON.
  C. signatus, KOCH, SARS, ULJANIN, BRADY.
  C. coronatus, CLAUS, LUBBOCK, HELLER, FRIC, HOEK.
  C. signatus, var. fasciacornis, CRAGIN.

Cyclops tenuicornis, as thus comprehended, is widely distributed and variable. European specimens in our collection have longer stylets, but seem otherwise identical. The nearest relation is *C. ater*, which is easily distinguished by the compact oval form of the thorax and the one-jointed fifth foot. In the stage previous to maturity the "signatus" form has no teeth upon the ridge of the last segment of the antennæ; it is then similar to the C. tenuicornis.

Cephalothorax broad; abdomen rather slender; antennæ reaching about to base of thorax, attenuated at the end; terminal joint with a knife-like ridge; formula –⏑⏑–⏓⏑–⏑⏑⏑⏑⏑⏑⏑–––; fifth foot composed of a long basal joint bearing a long spine and a terminal three-spined division; caudal stylets twice as long as last abdominal segment; setæ all nearly terminal, inner one long. Length 2.5 mm.

Common in America, England, continental Europe, etc. C. clausii, Poggenpol, is known to me only from the citations of Rehberg and the translation given by Cragin, hence I can not judge authoritatively of its validity. Certain points in the translation are obviously erroneous, as where the larger branch of the fifth foot is spoken of. No distinctions sufficiently clear to enable us to separate it from C. tenuicornis can be gathered.

III.—FIFTH FOOT 3-JOINTED.

(See Cyclops modestus.)

Antennæ 16-jointed.

There are a few forms which, although they might more properly be ranked with the previous section, seem rarely or never to acquire more than sixteen joints.

Sp. 18. Cyclops languidus, Sars.

Thorax attenuated posteriorly, caudal stylets exceeding in length the two preceding segments, internal seta short, half as long as the outer, the inner of the median setæ as long as the abdomen. Both rami of the first foot and the inner of the second are two-jointed. Second joint of the fifth feet sub-linear, armed with a seta and a spine. The fact that some of the feet have two-jointed rami suggests a young stage of some other forms.

This species has not been seen in America.

Sp. 19. Cyclops modestus, Herrick.

(Plate R. Figs. 1—5.)

American Naturalist, 1883, p. 500 (May).

This small species, 1.0 mm. long, was first recognized in Cullman county, Alabama, but occurs also in our lakes. The color varies, but very characteristic is the peculiar shining or glaucous surface of the strongly arched thoracic shield and the evenly curved segments of the abdomen. The antennæ reach but little beyond the very long first segment; they are usually 16-jointed, but I have notes of a similar form in which the antennæ are 17-jointed. The feet are all 3-jointed and are peculiar in their armature. The fifth foot is obscurely 3-jointed, the second joint bearing a short spine and the terminal joint two spines of varying length. The stylets are once and a half as long as the last segment and are peculiarly excavated for more than the lower third, from the point where the lateral spine is situated. The outer terminal seta is short, the others being sub-equal and also short. The opening of the spermatheca is elongated, oval. The antenna of the male is divisible into five regions, the third being formed by the thickening and coalescing of four or more segments.

Antennæ 14-jointed.

Sp. 20. · Cyclops insignis, Claus.

The two forms here belonging might be considered atavic varieties of Cyclops pulchellus. Brady's figures and description of his *C. insignis* (= C. lubbockii) agree almost exactly with what Rehberg says of Cyclops helgolandicus (Abh. v. naturw. Vereine zu Bremen, vii. l. pp. 62—64). Rehberg regards that species as an atavic sub-species or variety of C. pulchellus. With C. insignis, Claus, the case seems to be different. The occurrence of this species is not conditioned by marine influence. I found it abundant about Leipzig, Saxony. The differences between it and the C. insignis of Brady are, as the latter says, very slight. Figs. 11—14 of plate T are drawn from Leipzig specimens, from osmic acid preparations. The first foot, outer ramus, has three external spines on the distal segment, two setæ at the end, and three within; the inner ramus has one internal seta, a spine and a seta terminally, and three external setæ on the distal segment. The outer terminal segment of the fourth foot is like the first; the inner one has only two external setæ. The external setæ of the caudal stylets exceed half the length of the stylet and are pectinate. The fifth foot has a short basal joint armed with a single seta, the second joint being slender and armed with two unequal setæ. The gathering above mentioned, taken near Leipzig, Dec., 1881, contained scarcely a female among scores of males in various stages of development. This is so contrary to what is expected that, notwithstanding the apparently good characters on which the species is founded, an uncertainly exists in the mind of the writer as to the permanent adult characters of this species.

Antennæ 12-jointed.

I.—FIFTH FOOT 2-JOINTED.

A.—*Terminal segment of fifth foot with a seta and a small spine.*

Sp. 21. Cyclops capillatus, Sars.

"Cephalothorax sub-ovate; anteriorly uniformly rounded; segments projecting somewhat laterally, the last being scarcely wider than the first abdominal segment. Abdomen attenuated posteriorly; caudal rami almost as long as the last three abdominal segments, hardly divergent, the external and internal apical setæ short and nearly equal; the interior of the median setæ as long as the abdomen; lateral seta about in the middle of the stylet. Antennæ of the first pair robust, slightly exceeding the first segment of the body when reflexed, with the twelve joints densely covered with long and divergent hairs. The last joint of the outer rami of swimming feet are elongated and armed externally with three spines, internally with four setæ; the interior apical spine of the interior rami of the fourth pair of feet longer than the exterior. Feet of the fifth pair large, with a large and thick basal segment and a small oval second joint bearing one long seta and a short spine. Ova-sacs small, narrow and divergent. Eye very small. Length nearly 2 mm."

Very close to C. viridis in many points. Found only in Scandinavia.

Sp. 22. Cyclops crassicaudis, Sars.

Cephalothorax elongate-ovate; segments produced laterally, especially the last, which extends into a somewhat procurved process. Abdomen short and thick, first segment somewhat excavated; caudal rami equalling the last two segments of the abdomen. External apical seta longer than the internal, both short; median setæ long. Antennæ of the first pair 12-jointed, scarcely longer than the first segment. Swimming feet short and thick, spines and setæ short; the interior apical spine of the last joint of the inner ramus of the fourth foot almost twice as long as the exterior spine. Terminal joint of the fifth foot small, armed with a spine and a seta; seta of the basal segment short. Ova-sacs oval, somewhat divergent. Length 0.75 mm.

Found only in Scandinavia.

II.—FIFTH FOOT 1-JOINTED.

Sp. 23. Cyclops varicans, Sars.

"Cephalothorax ovate, attenuated about equally in front and behind, with the last segment wider than the abdominal segments, produced laterally and bearing a long seta. Abdomen elongate; caudal rami scarcely as long as last two segments; the internal apical seta twice as long as the outer; median pair elongated, the internal one as long as the abdomen. Antennæ 12-jointed, robust, shorter than the first thoracic segment. * * Both rami of swimming feet two-jointed. * * Feet of fifth pair rudimentary, with a single linear segment bearing a long spine. Ova-sacs long, divergent. Length 1 mm."

Very possibly the young of some species not now identifiable. Only mentioned by Sars. (Compare C. diaphanus below.)

Sp. 24. Cyclops serrulatus, Fischer.

(Plate O. Figs. 17—19.)

? *Cyclops agilis*, KOCH (fide Rehberg).
Cyclops serrulatus, LILLJEBORG, CLAUS, SARS, LUBBOCK, HELLER, FRIC, HOEK, BRADY.
Cyclops longicornis, VERNET.
Cyclops pectinifer, CRAGIN.

Although Rehberg positively asserts that Koch's name applies to the present species, none of the numerous authors who have mentioned this most widely distributed form have employed any other than the familiar designation, and the practical advantage to be derived from its use seems to outweigh a quibble of doubtful synonymy.

Cephalothorax oval, compact; abdomen slender and short, suddenly enlarged previous to its union with the thorax; antennæ slender, reaching nearly, but not quite to the last thoracic segment; the last three joints are attenuated and furnish the most evident character of the species; formula – ⏓ ⏑ – ⏑ ⏑ ⏓ – ⏑ – – –; during life the antennæ tend to assume the form of a rude Z, the proximal four joints forming the base; antennules small, reaching about to the sixth joint of antennæ; jaws small with large teeth; the single segment of the fifth foot with three equal spines; egg-sacs oval, as long as the abdomen; eggs few, dark; caudal stylets very long and slender, spined along the outer margin; lateral setæ small and approximated to the upper one; outer terminal seta short, spine-like, in life set nearly at right angles to the others, spined or beaded on one margin and bristled on the other; the next seta is as long as the abdomen, being somewhat exceeded by the following one; inner seta as long as the outer, but feeble; upper seta nearly as long, approximated; length less than 1 mm.

A well marked variety of the above occurs in America, which might rank as a species, were it not probable that it is simply a post-imago form occurring only under favoring circumstances. This variety has no connection with Brady's var. montanus.

Cyclops serrulatus, var. elegans. (Var. n.)

Distinguished from the type by the greater size, and the elongation of antennæ and caudal stylets. We will first of all give the measurements which afford a criterion for judging of the form and proportions.

Total length 1.34 mm.; thorax 0.76 mm.; abdomen 0.40 mm.; stylets 0.18 mm.; greatest width 0.42 mm.; inner median caudal seta 0.60 mm.; outer median seta 0.36 mm.; inner seta 0.08 mm. The first segment of the thorax is long proportionally (0.40 mm.) The antennæ are very long, reaching to the base of the third segment (.68 mm.). The egg-sacs are elongate-oval, being more slender even than in typical C. serrulatus; in the animal measured they were 0.50 mm. long, by 0.19 mm. wide. The caudal stylets are slightly shorter than the last two segments of the abdomen. The antennules are very short, and each joint has its series of fine teeth. The free lower margins of the thorax are ornamented with series of prominences, while the last segment is extended into a blunt angle bearing long teeth. The last segment of the abdomen is spiny-margined and is ornamented with a double row of spines at the anus. The armature of the stylets as well as that of the feet is identical with that in typical C. serrulatus. The last two joints of the antennæ measure 0.1 mm. each, while the two previous measure unitedly 0.12 mm. The color is not opaque as in the smaller form usually. Brady's var. montanus has shorter stylets than the type, but seems nearest the small dark form found in peaty waters in America. Cyclops pectinifer, Cragin, has no distinctive points, it being typical C. serrulatus.

Sp. 25. Cyclops macrurus, Sars.

Cyclops macrurus, BRADY.

Closely allied with C. serrulatus. Cephalothorax ovate, rounded anteriorly; last segment fringed at the angles with numerous fine hairs. Antennæ much shorter than in C. serrulatus, about as long as the first thoracic segment, otherwise similar. Abdomen attenuated, penultimate segment margined posteriorly with spine-like setæ, the other segments pectinated. Caudal stylets very long and slender, about equal in length to the three segments preceding, bearing a group of four to five spines on the outside near the end, otherwise unarmed. Length 1.3 mm.

Here is the natural place for C. spinulosus, of Claus, but there is strong reason to suspect the validity of the species so very imperfectly characterized.

Sp. 26. Cyclops fluviatilis, Herrick.

(Plate Q^5. Figs. 1—9.)

Cyclops magnoctavus, CRAGIN.

This small species with twelve-jointed antennæ and conspicuous coloration is widely distributed through the Mississippi valley. The original description is appended.

"Body elongated; thorax very long; abdomen slender; stylets about as long or longer than last abdominal segment; setæ all very short, not [always] pectinate; lateral and dorsal setæ very small; outer one spine-like, short and stout; two median setæ short; inner one very small and inconspicuous; antennæ reaching nearly to the base of abdomen [or beyond]; formula –⏓⏑–⏓–––––––; the three joints following the six basal are much elongated, while the terminal ones are but moderately so, a character which is peculiar to this species; terminal segment slightly but evidently hinged and, together with pair preceding, somewhat curved; feet with the terminal spines strongly toothed; fifth foot very small, one-jointed, bearing three small setæ; operculum vulvæ heart-shaped; egg-sacs sub-quadrangular; eggs large; abdomen in the young much elongated. Color deep indigo. Length 0.7 mm."

The first foot has upon the last joint of outer ramus three external spines, two apical setæ and three internal setæ; the outer branch of fourth foot has three external spines, apically a spine and seta and internally four setæ.

Males of this species are slender, measuring about 0.75 mm.; the abdomen being 0.28 mm., stylets 0.6 mm., first thoracic segment 0.28 mm., and the longest caudal seta 0.24 mm. The antennæ are long and much modified so as to resemble superficially the antennæ of Diaptomus.

Antennæ 11-jointed.

Sp. 27. Cyclops diaphanus, Fischer.

(Plate R. Fig. 12.)

? *Cyclops bicolor*, SARS.
? *Cyclops minutus*, CLAUS, HELLER.

If not the young of other species, this is a widely distributed form, being known from Russia, Norway, continental Europe, Madeira, and America. The synonyms above given are upon the authority of Rehberg.

The following description applies to our American form found always in connection with C. thomasi, C. parcus, or C. navus.

Very small, measuring 0.81 mm., setæ not included. The thorax is 0.5 mm., the abdomen .31 mm., the stylets .06 mm., the longest caudal seta 0.4 mm., outer median seta .36 mm., the first thoracic segment 0.3 mm., and the egg-sacs sometimes 0.4 mm. The thorax is oval, the first segment being quite large, as in larval cyclops. The antennæ rarely reach the end of the first segment and are either 11-jointed or obscurely 12-jointed; their formula is –⏑–⏓⏑⏓–––⏑⏓⏓. The first joint is very large.

The second antennæ are of rather small size; the maxillipeds are armed as in C. navus. The feet have usually but 2-jointed rami, but in large individuals some of the rami are obscurely 3-jointed. The first foot has the terminal joint of the outer ramus armed with three exterior spines, two terminal setæ and three interior setæ; the inner branch has one internal spine, a terminal spine and seta and three external setæ. The fourth foot has the terminal joint of the outer ramus with two external spines, a terminal spine and seta and four internal setæ; the inner ramus has one internal spine, two unequal spines and three internal setæ. There is also a series of teeth at the place where the middle joint should appear. The fifth foot consists of a broad, basal segment nearly fused with the abdomen and bearing laterally a long spine; the terminal segment is terete and small, having a single terminal spine. The caudal stylets are but little longer than the last abdominal segment, which bears teeth below; the sides are parallel, and the lateral seta is ⅔ from base. The median setæ are long and toward the end show false jointing. The inner seta is longer than the outer which is, however, heavier. Eggs eight to twenty, in narrow elongate sacs. Not uncommon, everywhere.

Sp. 28. Cyclops phaleratus, Koch.

(Plate R. Figs. 6—10.)

(var. a.)
C. canthocarpoides, FISCHER, CLAUS, LUBBOCK, FRIC.
C. phaleratus, KOCH, SARS, ULJANIN, BRADY, REHBERG.
(var. b.)
C. affinis, SARS.
C. pygmæus. REHBERG.
C. adolescens, HERRICK.(—*C. perarmatus*, CRAGIN.)
?*C. lascivus*, POGGENPOL.

That the two varieties here united are very closely allied must be admitted; that they are merely age forms is possible. Claus in figure 2 of his plate II (Freilebenden Copepoden) figures some other species than the one described as C. cauthocarpoides, as can be gathered from the elongated stylets and the eight-jointed antennæ. Our Minnesota specimens combine the eleven-jointed antennæ of C. affinis with the short stylets and peculiar form of the fifth feet of the first mentioned. Rarely one is found with ten-jointed antennæ and at the same time sexually mature. The characteristic oblique lines of spines at the base of the stylets may be absent. Rehberg's figures of C. pygmæus agree very well with our species, but he has decided that it is not specifically distinct from C. affinis.

It appears to me undesirable to institute a new species for the American form, neither is it possible to sufficiently identify it with any of the above.

I here append a brief description of *Cyclops adolescens*, Herrick (=C. perarmatus, Cragin,) for comparison with the description of C. affinis as transcribed below. Thorax oval, broad, acute anteriorly; last segment large and separated by a constriction from the anterior ones. The head is beaked below; first throacic segment large and long (.36 mm.): last thoracic segment wide, united closely with the first abdominal segment, armed with series of teeth. Abdomen short, especially the last segment, which is toothed behind; stylets very short. The antennæ are much shorter than the first segment, eleven-jointed. The maxillipeds are very small. All the feet are armed with a row of very large teeth or lanceolate spines down one side; fifth foot one-jointed, with three spines, the outer being smooth, the others spiny; egg-sacs variable, narrow, appressed; eggs large, color usually dark. The animal moves like Canthocamptus, and is able to progress out of water better than other species. The following measurements will give an idea of the proportions: Length 1.26 mm.; thorax, 0.76

mm.; abdomen, 0.44 mm.; stylets, .06 mm.; longest seta, 0.34 mm.; antennæ, 0.28 mm.; width of thorax, 0.44 mm.

Cyclops affinis, Sars.

> "Antecedenti [C. phalerato] simillimus. Corpus autem minus robustum colore cœruleo vel potius glauco sat saturato insigne. Segmentum ultimum thoracicum ad marginem posteriorem extrosum pilis vel spinulis subtilissimis pectenatim exornatum. Rami caudales quam in C. phalerato aliquanto longiores, setarum apicalium interna quam externa multo breviore, intermediarum interiore altera fere triplo longiore longitudinemque abdominis superante, in medio aculeata dein vero subtile ciliata. Antennæ 1-mi paris segmento 1-mo corporis multo breviores, tenues, articulis 11 compositæ. Pedes 5-ti paris distincti, uniarticulati, setis 3, quarum interior ceteris multo major et ciliata, instructi. Sacci oviferi parvi abdomini appressi. Longit. circit. ¾ mm."

Cyclops ornatus, Poggenpol (=*C. clausii*, Heller, fide Rehberg,) is almost certainly, in our judgment, a young or atavic condition.

C. helleri, Brady, though not identical, is no more worthy a specific name. If every form with eleven-jointed antennæ and egg-sacs be worthy a distinct name, it will be possible to duplicate all the seventeen-jointed forms. Fortunately, however, many species agree together in this condition, so that the number of spurious species derived from this source is rather small; among these is to be reckoned *C. nanus*, Sars, which is obviously very near the pulchellus group.

Antennæ 10-jointed.

No valid species have permanently 10-jointed antennæ. C. phaleratus is frequently found with 10-jointed antennæ. C. kaufmanni is without much doubt an immature form.

Antennæ 8-jointed.

Sp. 29. Cyclops fimbriatus, Fischer (fide Rehberg.)

(Plate R. Fig. 11.)

C. crassicornis, SARS, BRADY, HERRICK.
C. gredleri, HELLER.
C. pauper, FRIC.
C. poppei, REHBERG.
(? *C. magniceps*, LILLJEBORG.)

Our American species corresponds to that described by Rehberg as a new species. The differences mentioned in the previous report (see Cyclopidæ of Minnesota, p. 233) are just those which have led Rehberg to establish the C. poppei, which, by the way, was found with the type. I see no reason, especially in view of the latter fact, to regard it as even a well marked variety.

C. crassicornis is widely distributed in America as well as Europe, but is never very common. The color is always reddish.

Antennæ 6-jointed.

Sp 30. Cyclops æquoreus, Fischer.

A brackish-water species, .85 mm. long, which in a number of characters departs from the type of the genus. Those who have the opportunity to search the brackish pools along our coast would do science a service by looking for this interesting species.

NOTE.—Cyclops navicularis, *Say*, is perhaps C. viridis of this report. C. setosus, *Haldeman*, (Phila. Acad. Sci., Vol. VIII, p. 331) is referred in my notes to C. serrulatus, I do not now know with how much reason.

The reader is referred also to *Cyclops latissimus*, Poggenpol, as quoted by Cragin-which, although belonging to the section having seventeen-jointed antennæ, and having feet like C. tenuicornis, is said to have a disc-like body, long-jointed antennules with no armature, and the basal joint of the abdomen very long.

Cyclops ornatus is quoted by Cragin, but we are left in doubt as to the number of segments in the antennæ, a point quite essential to the definition of species.

(See under C. phaleratus.)

Cyclops longicaudatus and *C. igneus* are thought to be simply prematurely gravid young of known species.

(See Cragin, l. c., (pp. 12—13.)

Cyclops fischeri of the same author agrees with C. æquoreus in having six-jointed antennæ, but in nothing else apparently. It is, if correctly described, a very remarkable form, with no setæ on the antennæ.

FAMILY HARPACTICIDÆ.

Numerically the largest of the families of the Copepoda, this group contains predominatingly marine and mostly minute animals, frequently of strange and grotesque form. A few of the marine forms, inhabiting the gulf of Mexico, are figured in the report of the Minnesota Academy of Sciences for 1881. Of the over thirty genera of the family less than a half dozen are not exclusively marine, and of these most are brackish-water residents. The genus Bradya contains blind copepods living in slime.

The name was proposed by Dana, but was dropped in the final report. Again revived by Claus, it is now in use by the best authors. The general form and structure closely resembles that of the Cyclopidæ. The following characters are the more important ones in distinguishing the family from the other families of the order:

Body flattened or sub-cylindrical. Abdomen usually not much smaller than the thorax, from which it is not separated by a sudden constriction; antennæ rather short, 4- to 10-jointed; mandibles strongly toothed, palpate; maxillæ well developed, palpate; first pair of maxillipedes with strong teeth at the end, second pair usually forming a claw. The first pair of feet are often turned forward or prehensile; fifth pair one- or two-jointed, serving as egg supports in the female.

Most species live among sub-aquatic vegetation.

THE SUB-FAMILY CANTHOCAMPTINÆ,

to which our sole genus belongs, is further distinguished from the other sub-families of Harpacticidæ by the fact that the seconp maxilliped has a prehensile hook. The feet of first pair are not clawed, but have the inner branch elongated, and the palp of the mandible is one-branched.

GENUS CANTHOCAMPTUS, Westwood.

These little animals may be secured in considerable numbers by gathering a supply of water from among weeds in shallow ponds, and permitting the debris to settle in a spot where light only touches the jar from one side, when the Canthocampti congregate on the exposed side.

Canthocamptus is an elongated animal, with the body divided rather obscurely into two portions, of which the first, or anterior portion, is largest. This part of the body has five segments, each of which has at least one pair of appendages. The first, consisting of the head proper with one of the somites of the body or thorax, as is discovered by observing that a pair of legs is attached to it, is the largest segment of the body.

As seen from above, it is triangular and extends in front into a short, stout beak or snout, like the rostrum of a cray-fish. Above the beak, in the center of the forehead, is the eye, consisting of pigment and two lenses, showing that we really have to do with two eyes confluent on the median line. This is the simplest form of a compound eye. The same method of compounding the eyes is exhibited in a more complicated manner by *Daphnia* and other Cladocera. On either side of the beak springs an antenna with six to nine joints of unequal size. The first three joints are profusely covered with hairs. The fourth joint is more slender than the preceding, and terminates in a process below, which bears besides a long hair a peculiar blunt bristle, that serves some unknown purpose—probably being sensory in function like the similar hairs on the antennæ of some Cladoceræ. The next joint is shorter than the rest, while the remaining three are spined at definite points. The antennæ of the male are curiously altered, or *geniculate*, on both sides, as in Cyclops. The three basal joints are shortened, while more or fewer of the following ones are coalescent, followed by a hinge joint and two elongated segments.

The second antennæ or antennules are two-jointed, and the basal joint has a two-jointed branch or palp; the terminal joint is covered with spines; at the end are longer and curved spines, jointed in the middle.

The mandible is a flattened plate with digitate teeth at the end, on one side of which springs a two-jointed palp, and from the other a blunt process. The maxilla is somewhat like it, but has rudiments of other elements.

The first pair of feet have two three-jointed rami. The outer ramus is shorter and with the longer branch is directed forward. The fourth foot has the inner branch two-jointed. The inner branch of the third foot of the male is peculiarly modified to form a prehensile organ, as it is this foot which fastens the spermatophore to the female. The fifth feet are composed of two flat plates.

The second division of the body, the abdomen, consists of five segments, of which, however, the first two are united in the female. The last segment of the abdomen bears two stylets, which are sometimes considered as together constituting an additional segment. Each of these stylets has, with several small spines, two elongated caudal setæ, one of which is usually as long or longer than the entire abdomen. The stylets are usually considerably longer than wide, but the proportions vary somewhat in different species.

Viscera. The body cavity is traversed by the alimentary canal, which is a straight tube with no lateral cæca or blind sacs, as in some other Copepoda. The canal is divided into four more or less distinct portions; the first section is a slender, muscular tube, extending from the mandibles nearly through the first segment, opening into the stomach proper, which is a muscular and glandular sac or tube, filling the greater part of the thorax; at the beginning of the abdomen, the sac is constricted and becomes the intestine proper; near the extremity again there is another change and the intestine loses its glandular character, and, by a peculiar adaptation becomes a sort of force-pump, which, during life, is constantly pumping water in and out, serving as a means of respiration. This anal respiration is quite common among aquatic animals in this as well as other orders. This latter section of the canal is the rectum, and opens beneath a toothed anal plate, above and between the stylets. No special divarications or cæca are appended to the digestive tract, and the only other organ which is at all considered to belong to the alimentary system, is what is known as the "shell-gland," present in most crustacea, but till recently thought to be absent in Canthocamptus. It is a coiled tube found in the lower part of the first segment of the thorax. It is impossible to find this organ in Canthocamptus, in every case, it being very obscure; and its office is uncertain, though it is supposed, perhaps with little reason, to be hepatic in function.

There is no functional heart in this animal, but its place is taken by a peculiar apparatus, hitherto undescribed ; this consists of a tube, surrounding the posterior portion of the alimentary canal. This sac around a sac is open in front, and serves by a double mechanism the office of a pulsating heart, though in a very imperfect manner.

There are no true hæmatic or lymph corpuscles in this animal ; so far, at least, none have been discovered. The place of these blood corpuscles is taken by globules of yellowish or red color of the most diverse size. These nutritive globules, or fat globules, as they have been called, are undoubtedly reservoirs of nutriment in a shape convenient for the animal's use, and equally certainly are derived from the contents of the intestine. In those Copepoda which have a functional heart, it is open anteriorly into a general body-cavity in the same way as in this animal. That a portion of the vascular system should surround the alimentary canal, is no unexampled thing, for in *Daphnia* a large sinus embraces a portion of the canal. The same provision as this described in Canthocamptus occurs in the Cyclopidæ. The nutritive globules are often very large, and are frequently extremely abundant, especially in females soon to become gravid. Three-hundredths mm. is not a large measurement for the diameter of such drops.

The nervous system is very hard to trace, consisting of a large pear-shaped ganglion just below the eye, from which extend commissures around the œsophagus, connecting them with the ventral ganglia lying between the bases of the feet. The senses are not apparently well developed, for, excepting the eyes, we cannot locate with certainty the organs of any sense. There are, however, two spots which are evidently devoted to special sense: first, the processes on the fourth joint of the antennæ, which may be simply the seats of tactile sense, or may have nerves suitable for perceiving chemical stimuli; second, the area on the forehead bordered by a raised line and covered with little pits, each with a small bristle. The character of this organ can be but conjectured; it may be homologized with the frontal nervous organs of the Cladocera.

The sexual organs are quite extensively developed, and periodically obscure the remaining viscera. In the male the simple testis is situated in the second segment, and the single vas deferens after numerous windings through nearly the entire length of the body, opens at the base of the first abdominal segment under a spined plate. A part of the vas deferens is of a glandular character and secretes an elongate tube, the *spermatophore*, which serves to contain the spermatozoids, and is fastened by the male at the opening of the median pore of the female; on contact with the water this tube, which is at first soft, contracts and presses the contents into the opening of the female organs. So long is the vas deferens that as many as three spermatophores are sometimes seen in the body at once. The spermatozoids are very small. The geniculated male antennæ are used in grasping the setæ on the tail of the female, and the curiously modified inner branch of the third foot of the male may assist in fastening the spermatophore upon her body. The ovary occupies the same position as the testes, and the two ducts are coiled in the body from end to end, opening in the median pore behind the fifth pair of feet. When the eggs are ready to be laid, they are forced out, carrying with them a film of the secretion of the lower, glandular portion of the ducts, which is of a collodion-like consistency, and which forms the enclosing sac. The young become fully developed sexually before they assume their final form, and it is not unusual to find ova-bearing females which are not only much smaller than the parent, but with considerable differences in the various organs.

This sort of heterogenesis is not uncommon among lower crustacea, for the young may differ much from the mother till after they have themselves produced young.

Four species have been recognized in America, of which one is certainly identical with a widely distributed European form, and a second is probably identical with an English species. C. palustris, Brady, seems to depart considerably from the norm of the genus and may prove a type of a marine genus. No true Canthocamptus is more than accidentally marine.

The ten species below enumerated are all that have fallen under the author's notice, though others may have been mentioned.

KEY TO THE GENUS CANTHOCAMPTUS.

Inner ramus of 4th foot	In. ram. of 1st foot			
2-jointed.	2-jointed.	1 mm. long; basal joint of 5th foot small		*C. gracilis*, Sars.
		0.5 mm. long; basal joint of 5th foot long.		*C. brevipes*, Sars (?).
	3-jointed.	Inner ramus of 2d foot 2-jointed.	Antennæ thick	*C crassus*, Sars.
			Antennæ slender.	*C. trispinosus*,[1] Brady.
				C. northumbricus, Brady.
		Inner ramus of 2d foot 3-jointed.	Stylets rather long.	*C minutus*, Mueller.
			Styl. short, oval,	*C. illinoisensis*, Forbes
8-jointed.	Male antenna normal			*C. hibernicus*. Brady.
	Male antenna reduced, hooked at the end			*C. ? palustris*, Brady.

Canthocamptus elegantulus, C. mareoticus and C. horridus are uncertain; probably referred to the wrong genus. C. stromii, Baird (= Dactylopus stromii,) C. rostratus, Claus (= Stenhelia ima.) C. virescens, C. linearis, and C. roseus of Dana, are marine Harpacticidæ of uncertain affinities. C. minutus of Claus is not sufficiently described, but appears to be the earlier condition of C. minutus, Mueller (C. staphynalis, Jurine).

Sp. 1. Canthocamptus gracilis, Sars,

Is elongated linear, with the abdominal segments smooth. Caudal stylets long and slender; external caudal seta about one-fourth the inner. All the feet with two-jointed inner rami; outer branch of fourth foot longer than the others, inflexed; basal process of fifth foot slightly expanded. Length 1 mm.

At Decatur, Alabama, was found a species of Canthocamptus which is different from any American species, and seems in many points nearest the above but, unfortunately, only a hasty sketch could be made at the time, and the notes are insufficient to define it. The form is not remarkably slender; the first and second abdominal segments are very large. The caudal stylets are slender and elongated, the inner seta being very long and curved, while the outer is quite short. The anal plate is covered with hairs only. The antennæ are normal, of moderate length, and the fifth foot has but a narrow process at the base.

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[1] Distinguished from the following by the presence of only three spines on the process of the basal joint of the fifth foot.

If this form be worthy a distinctive name, it may be called

Sp. 2. Canthocamptus tenuicaudis. (Sp. n.)

(Plate O. Figs. 15 and 16.)

? Sp. 3. Canthocamptus brevipes, Sars.

This small form is almost certainly the young stage of some other species; yet I transcribe the description.

"Corporis forma et magnitudine C. pygmæo non dissimilis. Segmenta abdominalia vero postice magis attenuata seriebusque aculeorum destituta. Rami caudales elongati duplo longiores quam latiores, setis apicalibus brevisculis parumque divergentibus, exteriore dimidiam longitudinem interioris non attingente. Operculum anale absque dentibus. Antennæ 1-mi paris breves, articulis ultimis duobus in unum confluentibus articulum. Pedes natatorii brevissimi, ramo exteriore intus setis destituto, interiore biarticulato in pedibus 1-mi paris longitudinem exterioris æquante, in sequentibus multo breviore. Pedum 5-ti paris articulus basalis intus in processum foliiformem, sat magnum et angustatum, articulum ultimum elongato-ovatum aliquanto superautem, exit. Color albidus. Longit. parum supra ½ mm."

Sp. 4. Canthocamptus crassus, Sars.

Robust; segments margined with pectinate bristles. Caudal stylets oval, contorted, constricted at the base. Antennæ thick, densely covered with long setæ. Fifth feet with long setæ; basal process rather small. All the feet excepting the first, with bi-articulate inner rami. Length 0.75 mm.

Sp. 5. Canthocamptus trispinosus, Brady.

(Plate O. Figs. 6—14.)

This species with the last and next has all the feet save the first with bi-articulate inner rami. Very near the next, from which it differs in the form of the fifth foot of the female, which has the basal process smaller, bearing only three spines, while the next has six, the second joint being longer and narrow. The male is unknown. Not yet identified in America.

Sp. 6. Canthocamptus northumbricus, Brady.

Body robust; antennæ long as first segment, nine-jointed; mandibular palp minute. In the male the inner branch of the third foot is three-jointed and dactylate, as in C. minutus.

Canthocamptus northumbricus, var. americanus. (Var. n.)

(Plate O. Figs. 6—14, 20—22.)

One of our most common species is very near the English form, so near, in fact, that I dislike to remove it from it. A few points of divergence, however, may be mentioned.

The form and proportions are much like those of C. minutus. The head is large and ends in a prominent bent beak. The antennæ are rather long and slender and have a well marked flagellum. (Brady figures no flagellum). The palp of the antennule is as in C. minutus. The mandibular palp is small. The first pair of feet normal, rather small; all the other swimming feet with two-jointed inner rami, save in the case of the male third foot. The fifth feet are exactly as figured by Brady, save that there is a prominence or tooth of the basal segment near the point of attachment of the terminal joint which is quite long. The sensory area of the head is oval and pointed. The male antenna has a long flagellum, not, as figured by Brady, a very short one. The egg-sac is very large, oblong. The animal seems to fall short of the size of the English species, though measuring upwards of 0.65 mm. Our form is very well distinguished from any other species. It is found in lake Minnetonka, lake Calhoun, and elsewhere.

Sp. 7. Canthocamptus minutus, Mueller.

Monoculus staphylinus, JURINE.
Canthocamptus minutus, LILLJEBORG, BAIRD, SARS, ULJANIN, BRADY, HERRICK.
Canthocamptus staphylinus, CLAUS, FRIC.
Canthocamptus minutus, var. occidentalis, HERRICK.

A well known species which has been frequently described and seems quite circumpolar in its distribution.

First mentioned from America in a paper by the writer in 1878. A pretty full description will also be found in the author's *Types of Animal Life.* A very abundant species, frequent in muddy pools, but somewhat variable in abundance. It may frequently be found in great numbers in winter.

Sp. 8. Canthocamptus illinoisensis, Forbes.

(Plate O. Figs. 1—5.)

This robust and pretty species was first taken near Minneapolis, by Mr. A. W. Jones, a student of the University, who found it in a peaty ditch. Forbes' description is appended.

"Length 1 mm. Head and first segment united; five abdominal segments in male, four in female. The suture between the first and second segments is not wholly obliterated above in the female.

Last abdominal segment is deeply and acutely emarginate. Branches of *furca* as wide as long, inner bristle plumose, a little longer than abdomen; outer plumose only on outer side, about half the length of the inner. The second to fifth *abdominal segments* have each a row of spinules along ventral portion of posterior,

Male with *anterior antennæ* composed of seven joints, the fourth joint very short. The front outer angle of the third is produced, the blunt process bearing three long bristles surrounding a slender olfactory club which is as long as the three following joints. The penultimate joint bears a strong spine or slender appressed process at the middle of its posterior margin. The five outer joints constitute the grasping organ. The *posterior antennæ* bear five long bristles at tip, three of which are made prehensile by the occurrence of from eight to twelve short articulations in the middle of the hair, allowing it to be bent forward. At the base of these articulations on the outer bristle, are two short spinules. Two nearly longitudinal rows of five or six strong, short spines each appear on the under surface of the outer joint of the antennule. The secondary flagellum, borne as usual on the middle of the basal joint, is not articulated, and bears four long bristles, two terminal and two on distal half of inner side. The outline of the *mandible* is exactly like that figured by Claus, but it bears about ten teeth, the upper thick and blunt, the inner sharp, slender and longer. Several are notched at tip. The lower angle bears a long simple bristle. *Mandibular palpus* two-jointed, second joint with three long terminal hairs and a shorter spine attached at basal third of anterior margin, jointed at base and directed towards tip, like a dactyl. The *maxilla* and *maxillary palpus* are scarcely to be distinguished from those of *C. staphylinus.*

The first maxillipeds are three-lobed, the outer lobe constituting a long, strong claw. The second and third are about one-third as long as the first, and bear each one strong simple spine and one weak branched hair. The inner lobe is widest, about two-thirds as wide as long. The dactyl of the *posterior maxilliped* is spinous on its inner edge, and the same edge of the hand is ciliate and bears a short, stout, sparingly plumose bristle at its base, just beyond the tip of the closed dactyl. The width of this joint (the second) is nearly half its length.

Basal joint of inner ramus of *first pair of legs* nearly or quite as long as outer ramus, the second wider but only half as long as the third, and obliquely truncate. Inner ramus of *third pair of legs* in male is three-jointed, [the outer two-jointed,]* chelate. The finger is ovate, truncate, terminating in two long plumose hairs. The dactyl is linear, curved at base, and twice as long as finger. The inner ramus of the *fourth pair of legs* is about half as long as outer, two-jointed, basal joint short, terminal joint about as long as middle joint of outer ramus. The *fifth pair of legs* is best developed in the female. In the male the length is not over one-third the width. The basal portion bears three plumose hairs on its very broadly rounded anterior margin, of which the innermost is longest. The outer plate is nearly orbicular and bears five spines on its terminal margin, of which the second from the internal angle is the longest. *Genital plates*, found in male at posterior border of first abdominal segment, beneath, are short, slightly expanded internally, with internal angles rounded, and externally bear three sub-equal bristles, jointed at base, the inner largest and strongest and semi-plumose. The *antennæ* of the female are eight-jointed, extending backward to the first free segment. The basal joint of the *fifth pair of legs* is sub-elliptical in outline, with the basal half produced externally into a broad, triangular process which bears the second joint on its posterior margin. The free end of the basal joint bears six large plumose bristles of which the inner is longest. The greatest width of the joint is nearly equal to its greatest length. The second or outer joint is ovate, sub-truncate, spined on each margin, and bears four plumose bristles at tip and one at the middle of its outer margin. Its length is about twice its breadth."

Sp. 9. **Canthocamptus hibernicus**, Brady.

A small species differing from all others save the next in having a three-jointed inner ramus of the fourth foot.

"Anterior antennæ of the female slender, 8-jointed, about as long as the first body segment, and much like that of C. minutus. Inner branch of the second antenna very small, 1-jointed. Posterior foot-jaw having a broad hand armed with a long apical claw. Inner branch of the first pair of feet scarcely twice as long as the outer; first joint longer than the entire outer branch, and nearly twice as long as the united second and third joints, both of which are extremely small. Inner branches of the second, third and fourth pairs shorter than the outer, and 3-jointed, the first joint

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* Evidently a misprint, for it is the inner ramus which is chelate.

being very small. Inner segment of the basal joint of the fifth pair of feet in the *female* elongated, fringed, bearing two long and three short apical setæ; second or outer joint sub-ovate, finely fringed internally; externally bearing six long marginal setæ. In the *male* the limb is smaller, the basal joint short, broad and having six short setæ of equal length; second joint nearly like that of the female. Caudal segments somewhat longer than broad; inner seta about twice as long as the outer; anal operculum denticulate. Length .65 mm." Not found in America.

Sp. 10. **Canthocamptus palustris,** Brady.

(Plate K. Fig. 5.)

A brackish-water species about .9 mm. long, found in a number of places in the British Isles. The species presents several anomalies.

The antennæ of the female are 8-jointed; those of the male robust, the last joint forming a hook. The first four pairs of feet have both branches 3-jointed; the fifth pair in the *female* are 2-jointed, with a short and broad basal joint, the second joint being sub-ovate, bearing five long apical setæ; in the male the fifth pair is obsolete, being reduced to a minute setiferous lobe. Caudal segments short, bearing two principal setæ, the outer half as long as the inner.

Sp. 11. **Canthocamptus minnesotensis.** (Sp. n.)

(Plate T. Figs. 1—6.)

Since the manuscript of this genus was finished, a small species has been found which seems undoubtedly distinct from any of the above. A single pair were taken in a gathering from Bassett's creek containing C. minutus in abundunce. Unfortunately the characters of the swimming feet are not certainly known, but they were apparently all three jointed save the last. The antennæ are very short and thick, 8-jointed, with a long flagellum; the antennules are of the usual form, and the mouth parts rather large. The first pair of feet have the two rami of nearly equal length. The form is moderately elongate. The caudal stylets are very short, quadrate in outline and well armed with spines. The fifth foot of the female has four long and two short spines on the inner lamina, and the terminal joint has five unequal spines. In the male the fifth foot has two spines on the lamina and six on the second joint, one being a small bristle. The male antenna is of peculiar form. The teeth of the anal plate are large and emarginate (see fig. 4.)

The swimming feet are all armed with very strong spines, aside from the usual quota of spines at the end of each joint. Length .65 mm.

NOTE.—*C. frontinalis*, Rehberg. This author seems to have parted with his usual acumen in the remarks upon this species. After describing a Canthocamptus with the inner ramus of the first foot "reichlich doppelt so lang wie die beiden Grundglieder des Aussennasts," he draws a moral on the mutability of genera from the fact that Brady founded the genus Attheyella "auf grund der Eingliede des innenastes am fierten Fusspaare und einer derartigen Bildung des ersten Fusses, wie er bie C. frontinalis beschreiben ist." Brady says (Brit. Copepoda, p. 58): "inner branch of first pair of feet scarcely at all elongated, and either 2- or 3-jointed," etc. The distinctive characters being the 1- or 2-jointed 2d and 3d feet and the 1-jointed inner ramus of the fourth foot, it is doubtful if C. frontinalis is really new.

II. GENUS ATTHEYELLA, Brady.

This genus, the diagnostic characters of which have been above indicated, contains three nominal species. It is quite difficult to say what differences exist between Sars' "*Canthocamptus*" *pygmæus* and *Attheyella spinosa*. Brady did not seem to recognize the fact that his diagnosis included that species. The third species is the blind *A. cyrptorum*, of Brady, which it is interesting to compare with the blind Bradya limicola of the coast of the gulf of Mexico.

PŒCILOSTOMATA.

This group, consisting of animals more or less like Cyclops in appearance, but, during part of their existence, semi-parasitic, has been very little studied in America. Most of the fresh-water species inhabit the gill-cavities of fishes. The gills of fishes should always be examined (if practicable, microscopically) for these interesting animals.

The mouth parts are greatly reduced and their homologies uncertain.

GENUS ERGASILUS, Nordmann.

Body shaped much as in Cyclops; anterior antennæ short; antennules in the female large, four-jointed, terminating in a strong claw. Mouth opening in the center of the very large head, which is not beaked in front. The mouth parts are inconspicuous, but the maxilliped is a stout organ terminating in a long claw. The three anterior pairs of feet are bi-ramose, and each ramus is three-jointed; the outer ramus of the fourth foot is two-jointed; the fifth pair is absent or rudimentary. The abdomen is four or five-jointed, and the stylets are rather short. Ova-sacs two, large.

Ergasilus depressus, Sars.

(See Forhandlinger i Videnskabs-Selskabet, 1862.)

The form figured in plate S., fig. 1, is known from a gathering taken under the same circumstances as Sars' specimens, and consisted only of males. The animal is very transparent with deep blue markings below, especially between the bases of the feet. Sars thinks the males are always free, while the females early retire to the gill-cavities of fishes. This species may be distinct from the Norwegian form, but there is no reason for declaring that it is so.

E. depressus is probably the young of the widely distributed E. sieboldii.

NOTE.—As the systematic part of this work draws to a close, a note is received from Prof. Birge, who was so kind as to glance through advance sheets of the portion upon Cladocera. Prof. Birge informs me that his *Scapholeberis nasuta* is the same as S. (Daphnia) aurita, Fischer, as published in 1849 in the *Bull. Naturforsch. Gesellsch. in Moscau,* Bd. 22. This paper I have not seen. At Prof. Birge's suggestion, then, read on page 43.

Sp. 4. **Scapholeberis aurita,** Fischer.

Daphnia aurita, FISCHER.
Scapholeberis nasuta, BIRGE.

CHAPTER IV.

COLLECTING, PRESERVATION AND MISCELLANEOUS NOTES.

The appliances employed in the capture and study of Entomostraca are, in the main, those employed by the student of aquatic vegetation. The first in order of importance is the hand-net and its accompaniment, long rubber boots, such as cover the entire leg being preferable. Thus equipped, the student can collect by far the greater number of fresh-water crustacea. The net is best made by obtaining an ordinary gaff or dipping net of extra strength but small size. If jointed, the ferrule must be unusually strong, not, indeed, because of the weight or activity of the prizes, but because it is often necessary to lift a net full of water, which is a greater strain than the strongest fish would produce in a net with open meshes. The ring of such a net is furnished with a medium-sized bag of some porous but still rather close fabric. The writer usually uses for this purpose the thinner variety of flour sacking. This material fulls a little when wet, and permits the water to pass rather too slowly, but this is a good fault. The net is used in shallow water and among weeds. After the net has been repeatedly filled and permitted to drain nearly empty, the bottom of the net is seized and the small remaining amount of water is thrown by a dexterous movement of the hand into a large-mouthed jar, several of which are needed. By this method the animals can be secured in any desired degree of concentration, so to speak, provided care is taken to avoid fouling the net with fine mud or debris. A single jar should usually contain only a gathering from a single locality. In case the collection is not to be examined at once, the gathering, which must now be quite free from admixture of mud and filth, is concentrated as much as possible, and then poured into a thin filter-paper or a thin muslin bag. When nearly dry, the funnel is held over a small bottle, an opening is made in the apex of the filter, and the contents washed through with slightly dilute glycerine. Soon after pure glycerine is added so as to bring up the whole to the required degree of concentration. A sufficiency must be used to well cover up the whole. In case of haste the end of the filter containing the gathering may be torn off and placed at once in a bottle of glycerine or alcohol.

For the collection of Cypridæ it is recommended to use a very thin fine net, and gather as much as possible of the finely comminuted debris which settles in weedy pools. Spread this material in shallow pans and in an hour or so skim the surface with a small spoon-like hand-net, and transfer with the addition of clear water to shallow porcelain plates. Such gatherings may contain Ilyocryptus, Monospilus, the hook-nosed Pleuroxids (=Percantha) and, perhaps, also species of Canthocamptus.

The entomostraca of the larger lakes must be sought by a different method. A net of larger size, and composed of very thin material is drawn after a boat which is kept moving in different parts of the lake. Such a net should be so weighted as to receive water from the surface as well as from several inches below it. The net is emptied occasionally with plenty of water into large bottles, which may preferably be placed in the dark if to be unexamined for some time. Water kept in the dark will preserve its animal life for a much longer time than if exposed to the sunlight.

A similar net may be placed in a rapid stream in such a way that it remains partly full, but does not overflow. The accumulations of a day may be thus gathered into little space. The faucets of the city water will frequently afford a good supply of animal life, and unfortunately in Minneapolis a rather large number of forms are worms of a suspicious and unpleasant appearance. It must be observed that for this purpose the faucet must be well open so that a good current is secured, otherwise most of the impurities will be dropped on the way. A friend mentioned that very little life was found in the city water after long and careful experiment, during which, however, a very small stream was allowed to trickle through the complicated set of graduated screens. But the writer at the same time secured a rather large supply both of entomostraca and vegetable forms by simply permitting the water from the hydrant faucet to flow with full head through a muslin net.

But our methods are not yet exhausted. The dipping bottle frequently brings up animals quite different from those collected by the towing net at the surface. This consists of a large bottle weighted by a suitable bit of lead or iron and fitted with a tight-fitting cork or wooden stopple. The stopple is attached to the line fastened at the neck of the bottle in such a way that a sudden twitch of the cord opens the bottle when it has sunk to the required depth. Another method, when one does not object to mingling forms from all depths, is to lower a net weighted with a heavy ring to the bottom, there agitating it slightly and drawing it vertically upward. This serves in a poor way in the place of a dredge and will secure a larger gathering than the dipping bottle, and is quite as easily rigged. The collections secured in either of the above ways are placed in large shallow porcelain plates and, the microscope being ready, the study may begin. With a rather large hand-magnifier, with which, however, the student will soon be able to dispense entirely, the various forms seen swimming or creeping or springing about are scanned, chiefly for the purpose of noting their motions. The little black, brown or yellow imps springing on the surface are rapidly skimmed off as hindrances, and (if the student is interested in the Poduræ) consigned to a bottle of spirits. Next a great Belostoma, Corixa, Water-skater, Ranatra, or Dysticus requires the same treatment. Perhaps a half dozen "whirligig-beetle" require more time to dispose of, and then a careful removal of the dragon-fly larvæ and "water-tigers" leaves the coast comparatively clear save for sand-fleas and dipterous larvæ which must be endured as necessary evils.

With a narrow slip of paper folded trough-wise the desired animal is captured by a quick movement and the water permitted to drain off, when the specimen is placed on the object-carrier, and a square cover glass, one corner of which has been armed with a bit of wax, is placed over the animal and then adjusted so as to give the requisite amount of pressure to quiet its restless motions. The slip of paper is, in every way, more convenient than a dipping tube and avoids flooding the object-carrier. With a half-inch objective and suitable eye-piece the whole animal is drawn in as natural a position as possible, either with the aid of a camera or free hand, by the assistance of careful measurements and a given scale. A one-fifth inch objective is now substituted and all possible details added. If any dissections are necessary, the cover glass may be removed, the slide placed upon a slip of black paper and the parts separated as far as possible by the aid of a watchmaker's glass or dissecting microscope.

Up to the present time almost the only reagent which could be employed for the instantaneous killing of Entomostraca with the body in its natural position and the preservation of the same was osmic acid, which partly on account of its expense, perhaps, seems rarely to find its way into our laboratories. And even this is but partially successful or causes such a dark color as to obscure what one most desires to see. The desideratum seems to have been supplied by the discovery of Prof. Hermann Fol that ferric perchloride produces not only an instantaneous death but a fixation of all the parts with very little coloration or shrinkage. The alcoholic solution is diluted to about 2 per cent. and applied to a small quantity of water in which the animal is swimming, or a more concentrate solution is added at once to the water of a vessel containing numerous Entomostraca. The water is poured off and the animals washed with alcohol of 70 per cent., to which a few drops of nitric acid may be added to remove the ferric salts. According to Fol, in transparent animals the appearance is very little changed by this process. Specimens thus prepared may be preserved in alcohol and afford preparations for making thin sections. They do not take color well, but may be stained with gallic acid without difficulty.

As a preservative, glycerine does admirably for Copepoda, but no known fluid works satisfactorily for the Cladocera unless after such treatment as above indicated. Sections may be made by imbedding in soap, but the tissues of the Cladocera are so delicate that the writer never succeeded in making permanent preparations of such sections. Either the alcohol or the balsam as it flows in almost inevitably disturbs the natural position. 50 grammes of soap are dissolved in 200 cu. cent. heated alcohol of 96 per cent. The soap should be shaved very thin. A shallow paper trough is prepared and filled with the still warm mixture, and the animal, which lies in concentrated alcohol, is transferred into the solution and agitated till its tissues are permeated with the soap. When cold, the bit of soap is cut into the required form and is ready to be placed in the microtome.

As a preservative medium for Copepoda, Carpenters' gelatine answers well. It consists of clarified gelatine, one ounce to six fluid dramchs of pure glycerine. The preparations mounted in this require no cement, as the gelatine is quite firm when cold.

APPENDIX.

The previous pages refer to the fresh-water crustacea simply and will give a tolerable idea of the variety exhibited in the fauna of the lakes and rivers of America. The majority of Copepoda are marine and the coasts of the United States will afford the student of marine entomostraca a rich harvest of curious forms. These animals are now being investigated, it is understood, by competent naturalists. In the meanwhile any notes may be of a temporary interest. The following jottings, which are the result of a few days stay on Mississippi sound, will give an idea of the fauna of the gulf of Mexico. They are extracted from a paper offered the Minnesota Academy of Natural Sciences.

FAMILY CALANIDÆ.

GENUS PSEUDO-DIAPTOMUS. (Gen. n.)

Resembling Metrida and Diaptomus; compactly framed; cephalothorax 6-jointed, last two segments coalescent above; head rounded in front, beaked; eye small; antennæ appearing 22-jointed in both sexes, longer than the thorax; the right male antennæ geniculate as in Diaptomus; antennules bi-ramose, both rami rather short, inner one seeming but two- or three-jointed; mandible ten-toothed; maxillipedes well developed; feet all bi-ramose save the last, both rami 3-jointed; first feet smaller; fifth feet with inner ramus obsolescent, in the male nearly as in Diaptomus, in the female rather slender, simple, three-jointed; abdomen in the female 3-jointed, in the male 5-jointed; stylets in the female longer; ova-sac single; spermatophore pear-shaped.

This genus is of unusual interest on account of its close approach to the fresh-water section of the family.

The spermatophore in this genus is large and swollen and, as seen through the body of the male, is liable to be mistaken for eggs.

Pseudo-diaptomus pelagicus. (Sp. n.)

Rather compact; thorax alike in the sexes, antennæ short, seeming 22-jointed; first foot small, both rami 3-jointed; fifth feet in the male with but small rudiments of the inner rami, basal portion heavily armed with short teeth, otherwise almost as in *Diaptomus*; fifth feet of female slender, alike; abdomen in male very slender, with short stylets armed with five terminal setæ and a series of bristles on the inner margins, distal margin of segments of abdomen toothed; a series of spines also ornaments the middle of the first segment below; abdomen of female short and very spiny, first joint thick, second slender, oblong, third joint short; length of abdomen supplemented by that of the elongated stylets, which are spinulous on their edges; ova-sac ovoid, eggs numerous; opening of operculum vulvæ with lateral projecting lips.

This species is ornamented with irregular markings of brownish color which give it a strange appearance not observed in any other copepod. The size is like *Temora velox,* which the female resembles a little, a resemblance enhanced by the elongated stylets. By some changes in the definitions of *Metrida* and *Pleuromma* these three genera could be united, but there would then be no valid excuse for not admitting *Diaptomus*, so that, on the whole, it may be well to let matters stand until we reach some better understanding of the natural generic affinities of these animals.

Habitat, Mississippi sound, gulf of Mexico.

GENUS DIAS, Lilljeborg.

Slender; cephalothorax very long, narrow in front; abdomen with five segments in the male, in the female with three; antennæ 20-jointed, nodose; secondary branch of antennules one-jointed, small; labrum large; posterior maxillipeds short; swimming feet with 2- and 3-jointed rami; fifth feet with a single ramus.

Dias longiremis, Lilljeborg ?

Unfortunately the gathering was insufficient to determine with certainty the identity of our species with the above, but the female agrees quite well; and those points in the young males seen which could be compared with the descriptions of *D. longiremis* were sufficiently concordant. This species ranges, in the eastern hemisphere, from the North sea to the Mediterranean, and could be expected here. It is a very active animal and represents a well differentiated type.

GENUS TEMORA, Baird.

Elongate; thorax five-jointed, fourth and fifth segments closely combined; abdomen with four segments in the male, three in female; antennæ 24- or 25-jointed; right antenna of the male geniculate; mouth parts as in *Calanus;* inner branches of second, third and fourth pairs of feet two-jointed, of first one- or two-jointed; fifth feet with but one branch, prehensile in the male.

Temora affinis, Poppe.

= *T. gracilis*, HERRICK, MS.

The shallow bays and estuaries along the Gulf of Mexico swarm with a species of Temora but little unlike *T. velox.*

The body is much less compact, it being rather slender in both sexes; in like manner the caudal stylets are very much elongate, being nearly as long as in *T. longicornis* of Mueller, from which it is clearly distinguished by many obvious characters, and which seems to show an approach to *Metrida.*

The antennæ in male and female are just as in *T. velox*, and the fifth feet are little, if at all, dissimilar; the spine on the second joint in the female is not serrated, however, and the basal joint of the abdomen in this sex has three teeth on either side. The caudal stylets are about six times as long as broad in the female and densely spined, as is the last abdominal segment. The stylets are more slender in the male and have few spines, but the last abdominal segment has three larger spines on either side. Inner ramus of the first foot one-jointed. The animal is generally colorless, in autumn at least, but may be variously ornamented with prismatic colors, the most constant of which markings are a band about the stylets and across the thorax and between the bases of the feet. The ova are very numerous and carried as in *Diaptomus.* This species is littoral in habitat and ranges from salt-water bays to the fresh waters of rivers, along with several varieties of *Cyclops*, *Sida*, etc.

FAMILY HARPACTICIDÆ.

GENUS AMYONE, Claus.

Body much compressed; dorsal margin strongly curved; head very large, produced and angled below; antennæ 6- to 8-jointed; antennules palpate, 3-jointed; second maxillipeds long, chelate at the end; last thoracic and anterior abdominal segments enlarged; fifth feet leaf-like, large.

A very small crustacean, little over ½ mm. long, occurs in the gulf of Mexico in shallow water among vegetation. Insufficient material prevented its complete study, but it is nearly allied to *A. sphærica*, Claus, from which it differs in several particulars.

I can do no better than quote the remarks of Claus, the original discoverer of this peculiar genus.

"The body of this highly remarkable form, represents, in its general form, an intermediate stage between the nauplius (cyclops larvæ) and the mature copepods. The oval, almost spherical form, the slight development of the abdomen and the enlargement of the anterior thoracic segment recall the structure of the larva, while the almost complete segmentation of the body, the jointing of the antennæ and the swimming feet, as well as development of the reproductive organs, make the maturity of the creature certain." (Beitr. zur Kenntniss der Entomostraken.)

GENUS LAOPHONTE, Philippi.

Rather slender; antennæ 4-, 8-jointed; palp of antennules 1-jointed; mandibular palp 1- or -2-jointed; maxillæ palpate; first pair of feet slender, outer branch short, 3-jointed, inner branch elongated, 2-jointed; three following pairs with one ramus 3-, the other 2-jointed.

Laophonte similis, Claus?

The small crustacean which is referred to the above species occurs sparingly in the brackish waters of Mobile bay, and with *Temora* seems to be the only entomostracean not also found in the fresh waters adjacent.

From the few specimens found it could not be certainly determined that our species is identical with the European. The differences are, however, such as might be expected in immature specimens. Brady figures a similar reduction in the number of joints of the antennæ as that seen in our specimens. The fifth foot too, is less well armed with spines, but otherwise the agreement is tolerably close.

GENUS HARPACTICUS, Milne-Edwards.

Elongate or expanded laterally; head united with the first thoracic segment; first and second abdominal segments coalescent; antennæ 8-, 9-jointed; mandibular-palp 2-branched, large; second pair of maxillipeds strongly developed; outer ramus of the first pair of feet 2- or 3-jointed, inner ramus 2-jointed; first and second joints of outer ramus elongated, second joint of inner ramus short; both rami of following pairs of feet 3-jointed; ova-sac single.

Harpacticus chelifer, Mueller. (var. n. ?)

The species inhabiting the gulf of Mexico resembles *H. gracilis*, Claus, in the length of the setæ and some other peculiarities; but the antennary palp is more like *H. chelifer*, with which it closely agrees in most respects. Remembering that the entomostraca have their highest development in temperate and arctic regions, the small size and greater proportional length of setæ and stylets may be explained. *H. gracilis* from the Mediterranean takes the place of the true *H. chelifer* of the North sea, and is regarded by Brady as the same species. Our form would, in this case, stand more nearly related to the typical form. Both branches of the first feet are two-jointed and the antennary palp has three spines on its distal segment.

GENUS BRADYA, Boeck. (1872.)

Antennæ very short, 6-, 7-jointed; antennules of moderate size longer than antennæ, with a 2- or 3-jointed palp; mandibular palp large; maxillipeds rather large, outer branch (first foot-jaw of Brady?) much as in *Calanidæ*; first four pairs of feet nearly alike; fifth pair small, not lamellate.

This peculiar genus is not yet well circumscribed and defined, and it is much to be regretted that lack of time prevented from ascertaining how far the western species agrees with the generic characters of the European form and thus determining the validity of the assumed generic criteria. That our species is a member of the genus can not be doubted, but the hurried examination which could be devoted to it failed to cover the entire structure.

Bradya limicola. (Sp. n.)

Body flattened; free margins of the segments of the dorsal carapace rather long; little separation between abdomen and thorax; abdomen cylindrical, rather long; stylets short; distal margin of the segments spined; antennæ very short, 6- or 7-jointed, hardly longer than the movable beak; second antennæ much longer, 3-jointed; palp long, two-jointed; mandibles palpate, teeth fine, much as in Calanidæ; palp bi-ramose, second ramus very small; maxillæ of moderate size; maxillipeds large, outer one as in Calanidæ; first four pairs of feet bi-ramose, each ramus 3-jointed; fifth foot small, with two terminal digitate processes and a seta on either side. The male is at least a third smaller and has longer caudal stylets; the antennæ are modified, but very short. *The eyes are wanting in both sexes.* This very interesting species was collected in the brackish water of a ditch shaded by high sedges so that the sun could hardly penetrate. I did not find any representative of the genus in the open waters neighboring, but it is hardly to be doubted that such exist. This species is quite distinct from *Bradya typica* of north Europe.

The only other blind copepod with which I am familiar is *Attheyella*, which is circumstanced somewhat as the above.

The European *B. typica* is pelagic; ours dwells in darkened ditches and seems to furnish another illustration of the effects of seclusion upon the visual organs. Brady seems to have transposed the maxillipeds; these are really but branches of the same organ, as shown by the development, and the outer ramus is, probably, what Brady usually calls second foot-jaw but here first foot-jaw. In the characters of the mouth parts and fifth feet our species seems to show an affinity with the elongated higher copepoda.

Ocean Springs, Mississippi.

Caligus americanus, Dana and Pickering ?

A species of Caligus was collected at dusk far out in Mississippi sound in considerable numbers. The animals were floating in a bank of vegetation and swam freely. They seem not to differ greatly from the species described by Dana and Pickering in 1838 from the cod near New York. The fish lice are remarkable for their flattened bodies and the paired sucking organs on the head.

A species of Corycæus allied to *C. varius* of Dana was also collected.

NOTE.—Prof. Forbes, to whom advance sheets of the portion on Copepoda were sent, writes me that he somewhat questions the identity of the Minnesota species of Diaptomus referred to *D. leptopus* with the species for which that name was proposed. I do not know of any facts casting doubt upon the reference, but wish to call the reader's attention to the suggestion of Prof. Forbes.

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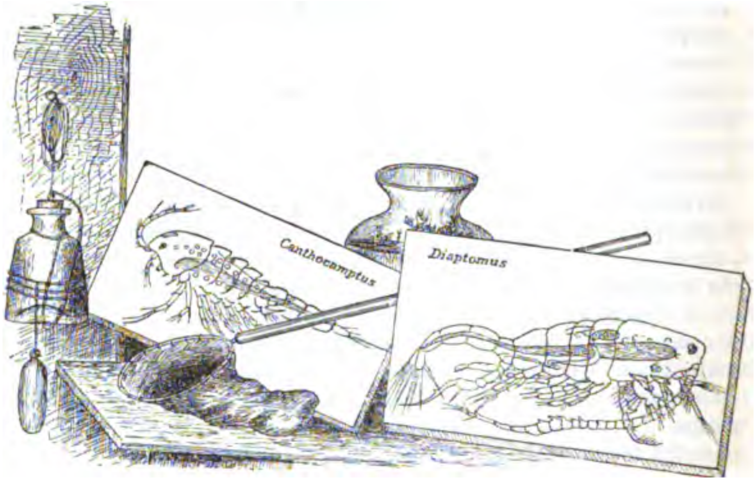
Canthocamptus
Diaptomus

PLATES OF PART V.

PLATE A.

Fig. 1. abdomen of *Moina paradoxa*, female, from Minnesota.
Fig. 1a. spine from post-abdomen.
Fig. 2. post-abdomen of *Moina rectirostris*.
Fig. 3. head of *M. paradoxa*, female, showing (a) eye with pigment and lenses, (b) supra-œsophagal ganglion, antennule with (c) its muscle, (d) its nerve, and (e) its terminal sensory filaments, (f) the cæcum of stomach, (g) optic ganglion, (h) stomach, (i) œsophagus, (j) the muscles which move the eye, also part of the labrum.
Fig. 4. antennæ of same.
Fig. 5. ephippium of *M. rectirostris*.
Fig. 6. " of *M. paradoxa*.
Fig. 7. seminal cell of *M. paradoxa*; 7a, a group less magnified.
Fig. 8. seminal cells of *M. rectirostris*.
Fig. 9. first foot of male of *M. paradoxa*.
Fig. 10. " " " " " *M. rectirostris* (from Weismann).
Fig. 11. male *M. rectirostris* (from Weismann).
Fig. 12. head of *Ceriodaphnia rotunda*. (This and the following numbers after P. E. Mueller.)
Fig. 13. head of *C. punctata*.
Fig. 14. " *C. pulchella*.
Fig. 15. " *C. reticulata*.
Fig. 16. " *C. quadrangula*.
Fig. 17. " *C. quadrangula*.
Fig. 18. post-abdomen of *C. quadrangula*.
Fig. 19. " *C. pulchella*.
Fig. 20. " *C. megops*.
Fig. 21. " *C. reticulata*.
Fig. 22. " *C. laticaudata*.
Fig. 23. " *C. rotunda*.

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12th Annual Report **PLATE A.** *Geol. & Nat. Hist.-Sur. Minn.*

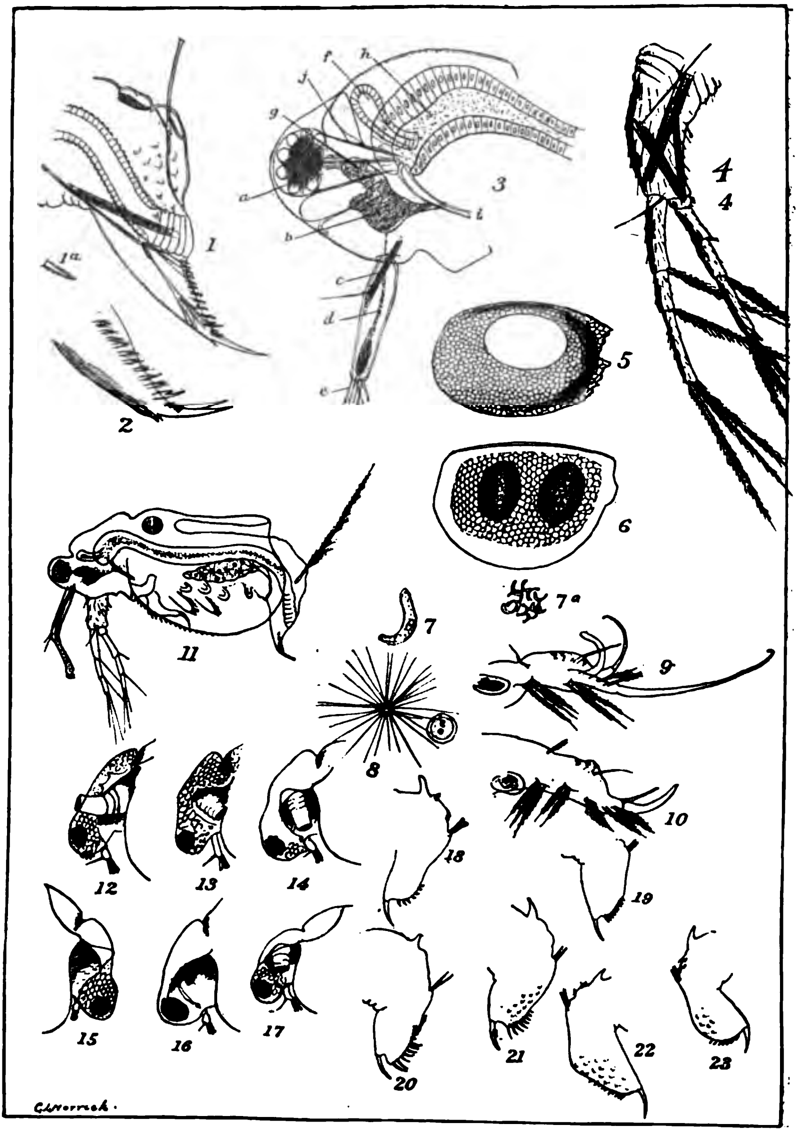

PLATE B.

Fig. 1. *Ceriodaphnia rotunda,* male (after Kurz).
Fig. 2. *C. alabamensis.* female.
Fig. 3. *C. reticulata,* post-abdomen of male with opening of vas deferens (after Weismann).
Fig. 4. *C. consors* ? ?
Fig. 5. *C. scitula*, head of female.
Fig. 6. do., post-abdomen.
Fig. 7. do., antennule of male.
Fig. 8. do., semen cell of male.
Fig. 9. *Scapholeberis angulata*, adult female; 9a. first foot.
Fig. 10. *Schapholeberis armata*, “
Fig. 11. do., view from below.
Fig. 12. *Lyncodaphnia macrothroides*, young.
Fig. 13. do., labrum.
Fig. 14. do., antennule.
Fig. 15. do., last foot, purple pigment in lower part.

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12th Annual Report *PLATE B.* *Geol. & Nat. Hist. Sur. Minn.*

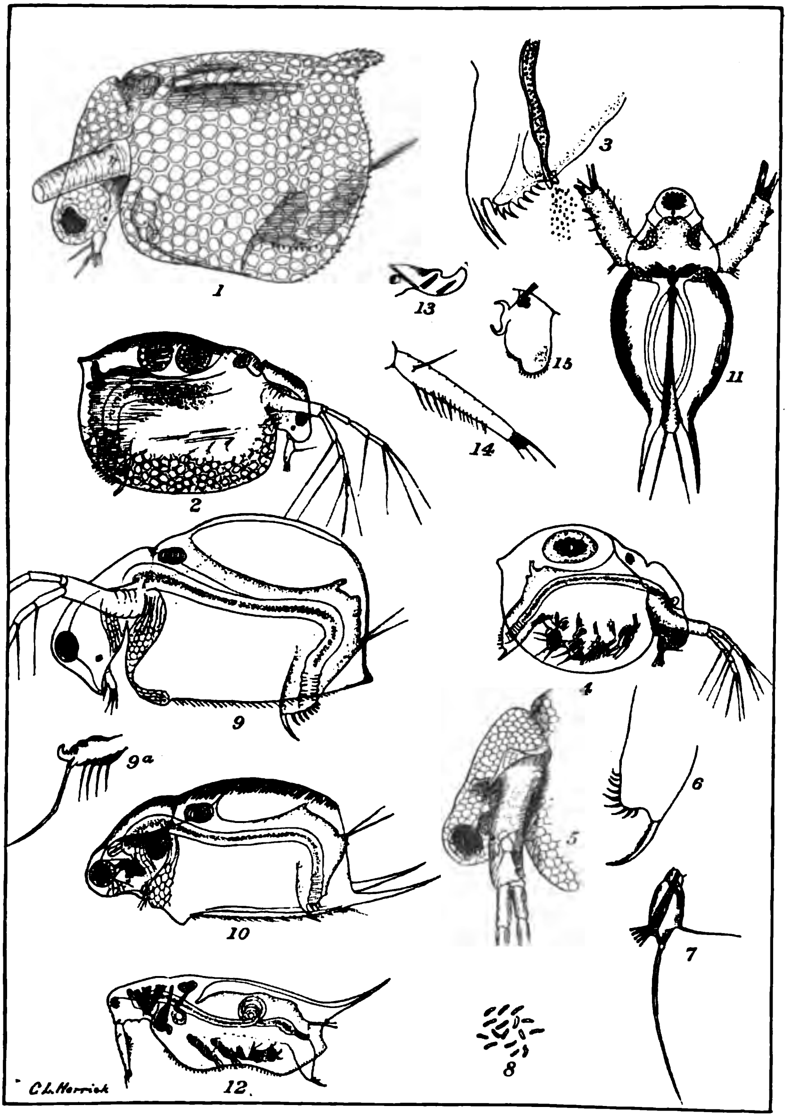

PLATE B^{1}.

Fig. 1. *Lyncodaphnia macrothroides* (= *Ofryoxus?*), **adult female, showing coiled intestine, elevated anus, long antennules, elongated seta of second antennæ, anterior cæca, etc.**

Fig. 2. **post-abdomen of the same.**

Fig. 3. **antennule.**

Figs. 4—6. *Polyphemus pediculus*, **young and adult females.**

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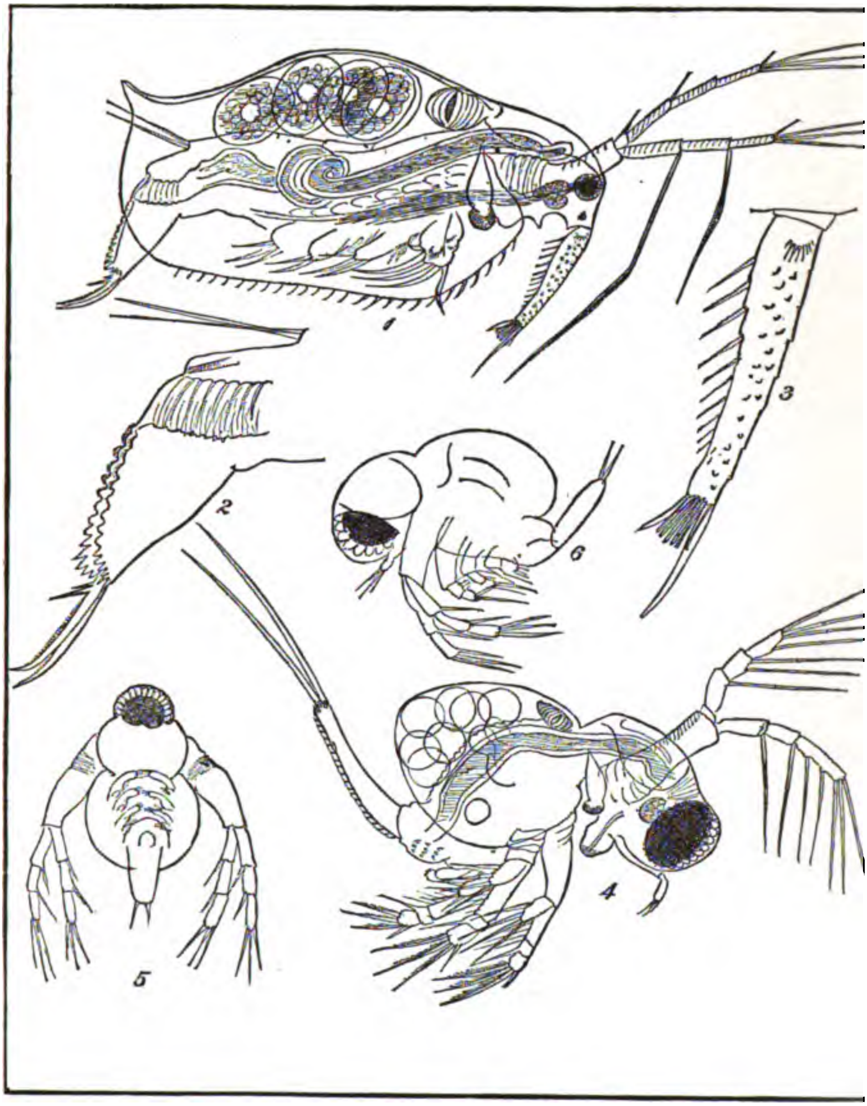

PLATE C.

Fig. 1. *Macrothrix tenuicornis*, 1a. labrum.
Fig. 2. do., first foot.
Fig. 3. do., antennæ of young.
Fig. 4. *Macrothrix pauper*.
Fig. 5. *Macrothrix rosea*, antenna of male.
Fig. 6. do., spines of shell-margins.
Fig. 7. do., post-abdomen.
Fig. 8. *Macrothrix laticornis*, male.
Fig. 9. do., semen cells.
Fig. 10. *Pasithea rectirostris*, male antenna.
Fig. 11. *Macrothrix rosea*, post-abdomen.
Fig. 12. *Macrothrix tenuicornis*, “
Fig. 13. *Macrothrix rosea*, post-abdomen of male.
Fig. 14. *Drepanothrix dentata*, antenna.
Fig. 15. *Ilyocryptus sordidus*, marginal spines.
Fig. 16. do., antenna.
Fig. 17. do., post-abdomen.
Fig. 18. *Ilyocryptus spinifer*, 18a. marginal spines.
Fig. 19. do., antenna.
Fig. 20. *Macrothrix tenuicornis*, heart and accompanying vessels.
Fig. 21. *Ilyocryptus spinifer*, post-abdomen.

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13th Annual Report **PLATE C.** Geol. & Nat. Hist. Sur. Minn.

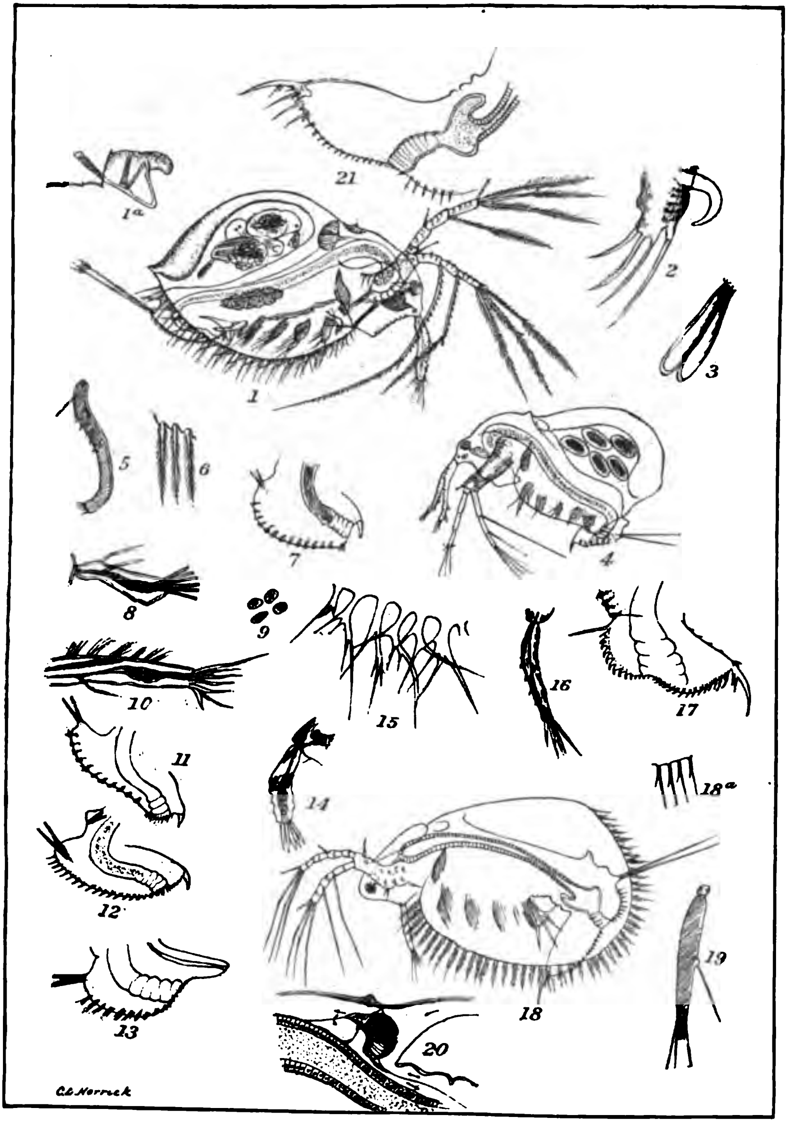

PLATE D.

Fig. 1. *Lathonura rectirostris.*
female. from above. a. eye. b. optic ganglion. c. muscles of eye. d. muscles of antenna. e. dorsal sucking disc. f. stomach. g. young in brood cavity.
Fig. 2. female, from side.
Fig. 3. head seen from below.
Fig. 4. maxillæ.
Fig. 5. first foot.
Fig. 6. ovary.
Fig. 7. antennule.
Fig. 8. last foot.

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PLATE D.

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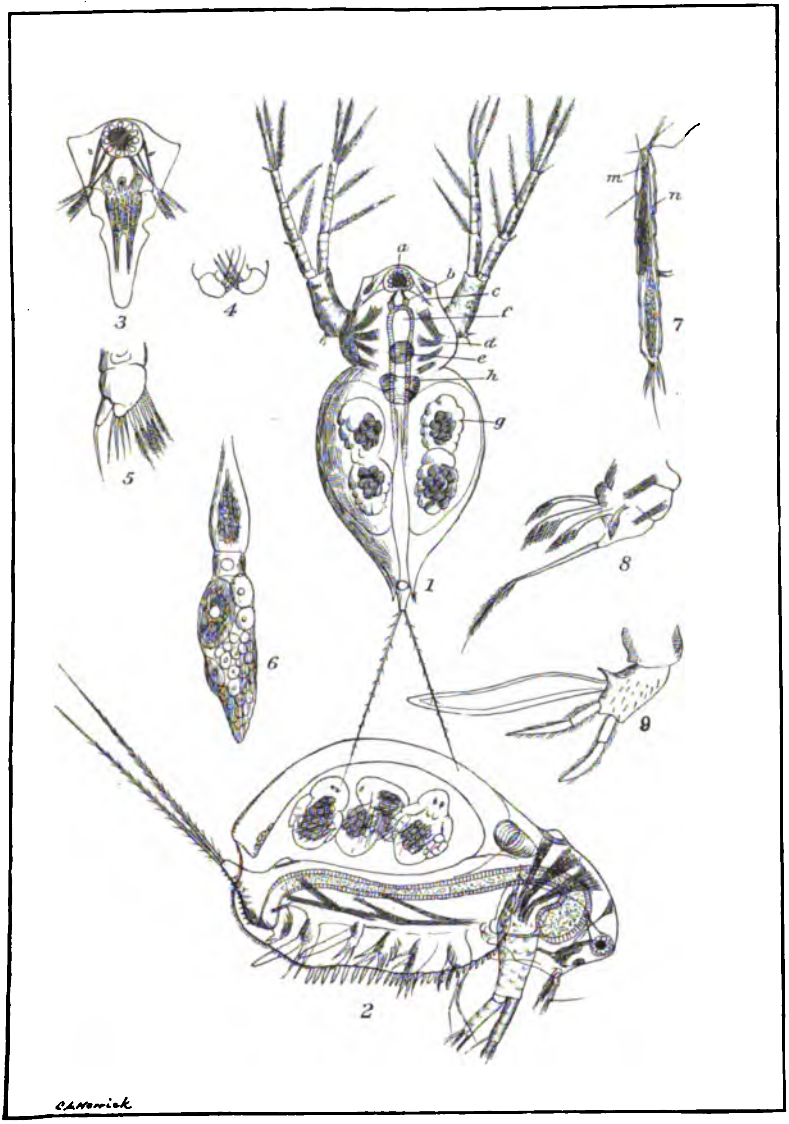

PLATE E.

Fig. 1. *Alona quadrangularis*, female.
A. antennule. Lb. labrum. Md. mandible. P-a. postabdomen. An. anus. F. c. musculus flexor caudalis. E. c. musculus extensor caudalis. A. g. anal gland. n. g. nutritive globule in embryo. t. tail of embryo. I, II, III, IV, V. five pairs of feet of embryo. mx. maxilla of embryo. at^2. antennæ of embryo. at^1. antennules of embryo. H. heart. Sh. g. shell gland. Ov. ovary. Md. m. muscle of mandible. At.^{2} m. muscle of antennæ. E. eye. s. œ. g. supra-œsophagal ganglion. P. F. pigment fleck.
Fig. 2. brain, eye and pigment fleck of same.
Fig. 3. *Pleuroxus procurvus*, female.
Fig. 4. foot of same.
Fig. 5. *Acroperus leucocephalus*.
Fig. 6. *Alonella excisa*, female; 6a. shell of same.
Fig. 7. antennæ of same.
Fig. 8. *Alonopsis latissima*, female.
Fig. 9. *Alonopsis media*, female.
Fig. 10. *Camptocercus macrurus*, post-abdomen.
Fig. 10a. lower angle of shell of same.

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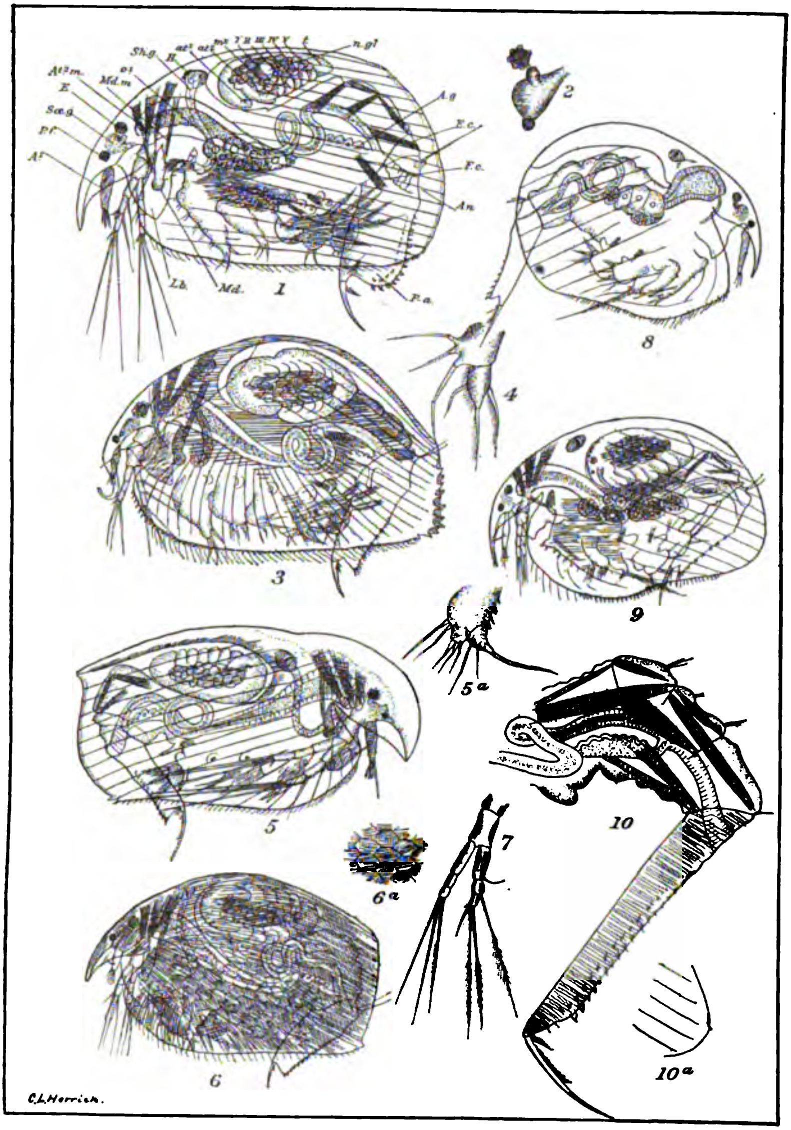

PLATE F.

Fig. 1. *Chydorus globosus.*
Fig. 2. do., first foot.
Fig. 3. do., end of post-abdomen.
Fig. 4. *Chydorus sphæricus*, male.
Fig. 5. *Chydorus nitidus*, post-abdomen of female.
Fig. 6. *Chydorus nitidus*, head.
Fig. 7. *Chydorus sphæricus*, ephippial female.
Fig. 8. do., female.
Fig. 9. *Chydorus globosus*, post-abdomen of male.
Fig. 10. *Chydorus sphæricus*, from above.
Fig. 11. *Chydorus ovalis.*
Fig. 12. *Chydorus cælatus.*
Fig. 13. *Crepidocercus setiger.*
Fig. 14. *Alona affinis.*
Fig. 15. *Pleuroxus unidens*; 15a. antenna.

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PLATE F.

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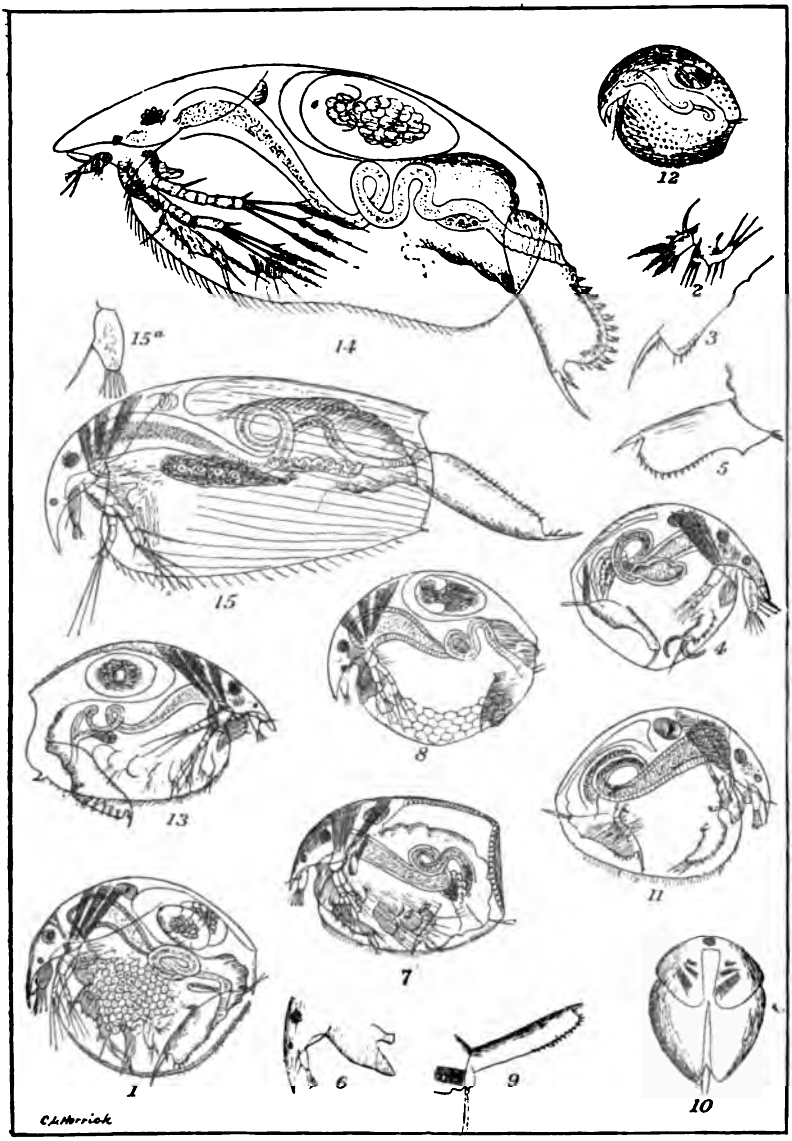

PLATE G.

Fig. 1. *Alonopsis latissima*, male.
Fig. 2. *Alona glacialis* ? female.
Fig. 3. do., male.
Fig. 4. *Alona tuberculata.*
Fig. 5. do., post-abdomen.
Fig. 6. do., labrum.
Fig. 7. do , antenna, setose branch.
Fig. 8. *Alona glacialis*, antenna.
Fig. 9. *Alonopsis latissima*, feet.
Figs. 10, 11. *Alonella excisa,* details of shell sculpture.
Fig. 12. *Pleuroxus denticulatus*, female; 10a. outline of ephippium.
Fig. 13. do., common variety.
Fig. 14. *Alona tuberculata*, var.

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12th Annual Report. **PLATE G.** *Geol. & Nat. Hist. Sur. Minn.*

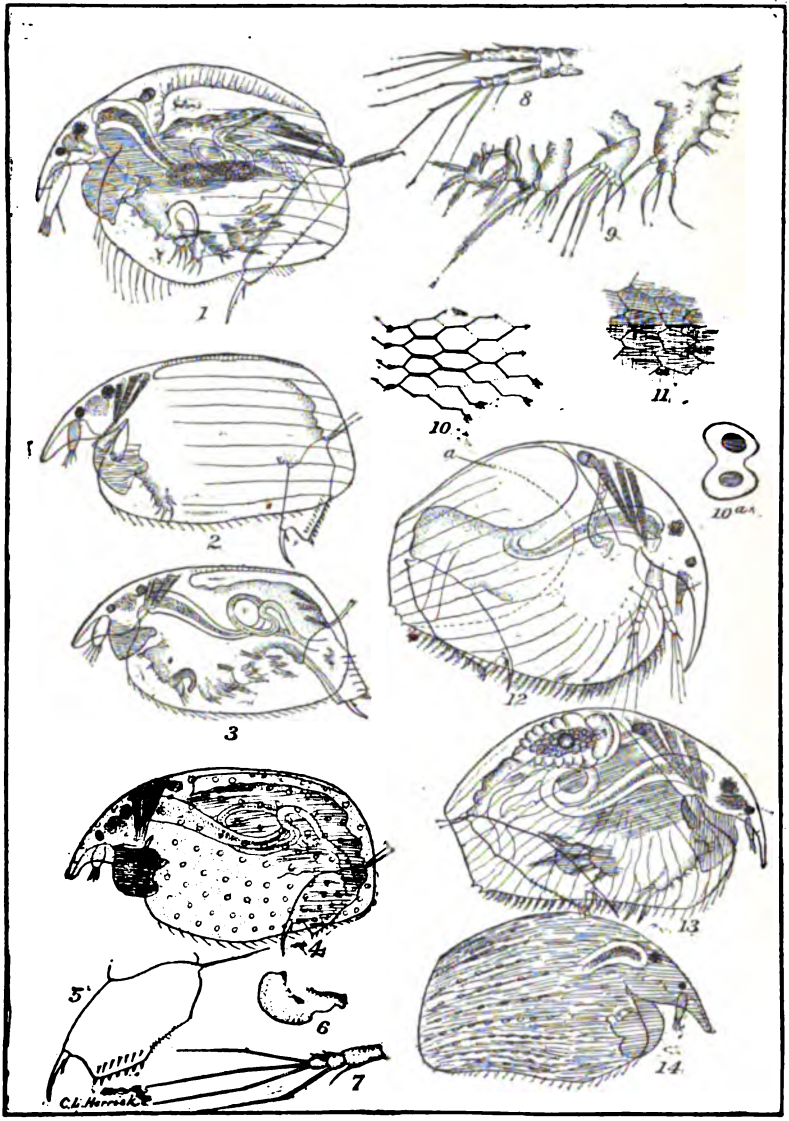

PLATE H.

Fig. 1. *Pleuroxus hamatus*, post-abdomen and antenna.
Fig. 2. *Pleuroxus affinis*.
Fig. 3. *Alona modesta* (= *lineata?*)
Fig. 4. *Leydigia quadrangularis*.
Fig. 5. *Eurycercus lamellatus*, male; 5a. posterior margin.
Fig. 6. do, antenna of female.
Fig. 7. *Alonella pygmæa*.
Fig. 8. *Temora affinis*, Poppe. female.
Fig. 9. do., abdomen of female.
Fig. 10. do., male.
Fig. 11. do., abdomen of male.
Fig. 12. do., fifth feet of male.
Fig. 13. do., " " of female.
Fig. 14. do., jaw.
Fig. 15. do., antennule.
Fig. 16. Nauplius larva of this or a related species.

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PLATE H.

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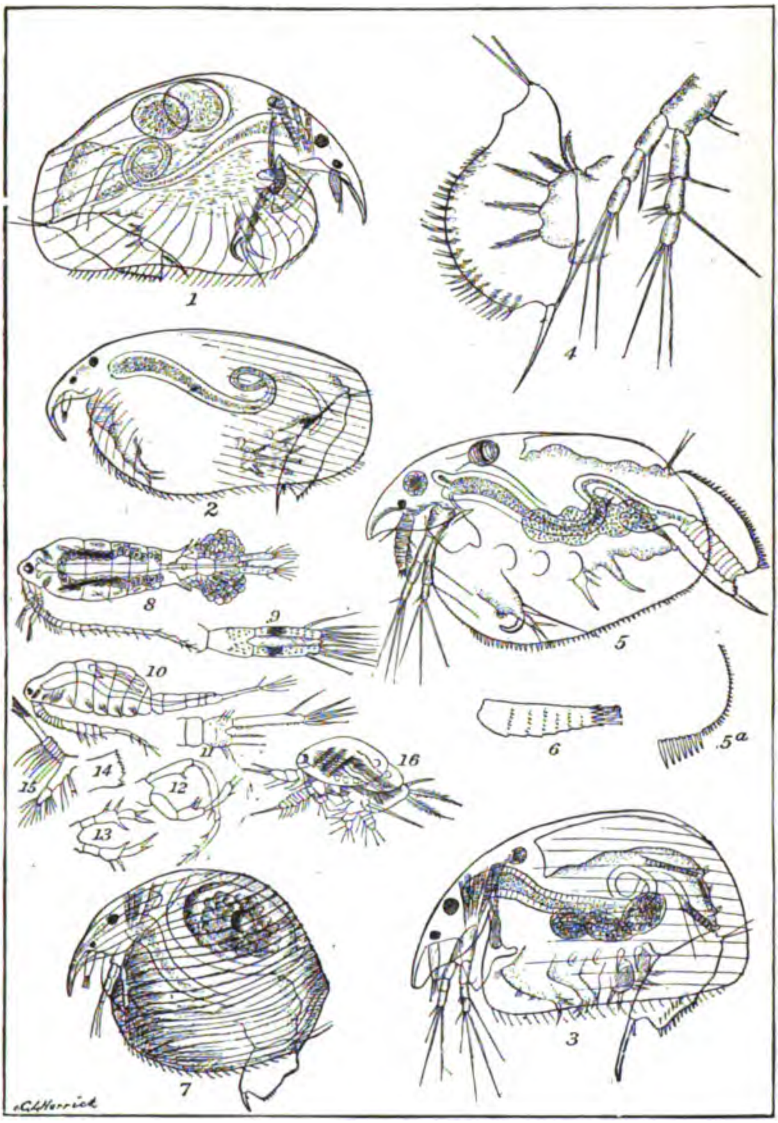

PLATE I.

Fig. 1. *Camptocercus rectirostris*, post-abdomen of female.
Fig. 2. do. post-abdomen of male.
Fig. 3. do. male.
Fig. 4. *Camptocercus biserratus*, head.
Fig. 5. *Camptocercus latirostris*, head of male.
Fig. 6. do., head of female.
Fig. 7. *Camptocercus lillgeborgii*, head.
Fig. 8. do., post-abdomen of female.
Fig. 9. *Acroperus leucocephalus*, post-abdomen of male.
Fig. 10. *Acroperus angustatus*, " "
Fig. 11. *Alona tenuicaudis*, post-abdomen.
Fig. 12. *Alona dentata*, post-abdomen.
Fig. 13. do. female.
Fig. 14. *Alona elegans*.
Fig. 15. *Alona intermedia*.
Fig. 16. *Pleuroxus hastatus*.
Fig. 17. *Leptorhynchus falcatus*.
Fig. 18. *Phrixura rectirostris*.
Fig. 19. *Eurycercus lamellatus*, first foot of female.
Fig. 20. *Alona sanguinea?* shell markings.
Fig. 21. *Monospilus dispar*; 21a. do., head seen from in front.

Figures 19-21 original, others from Kurz, P. E. Mueller and Schoedler.

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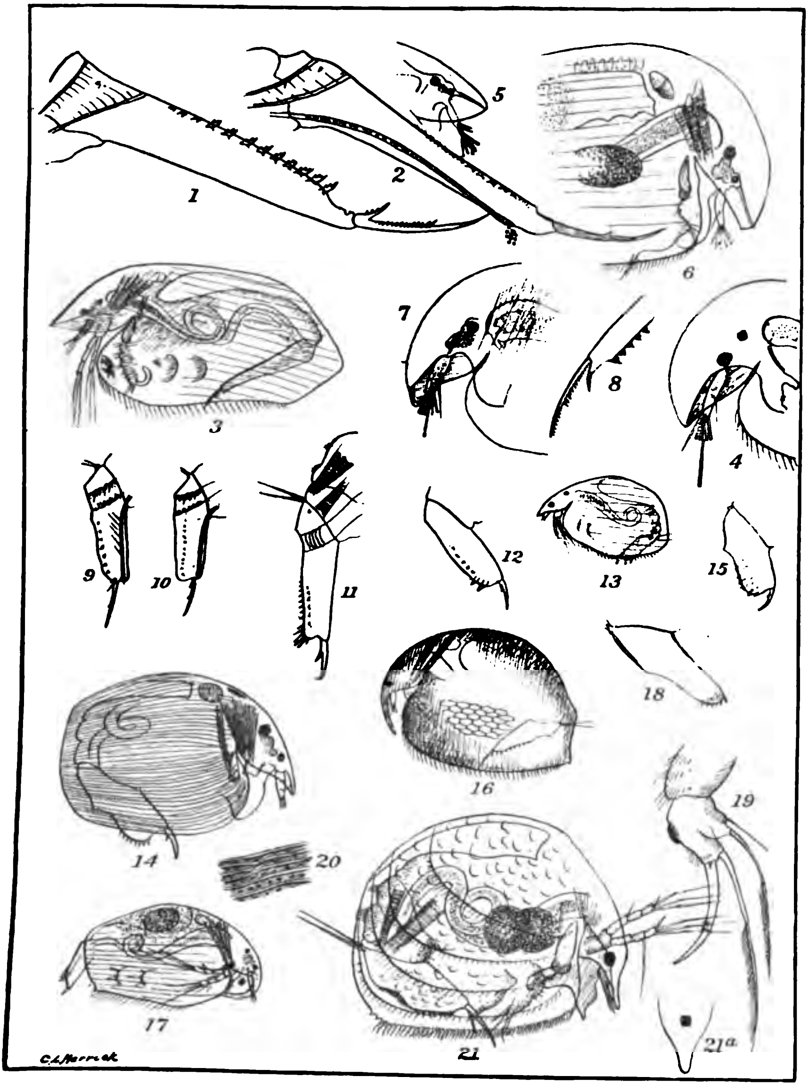

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PLATE J.

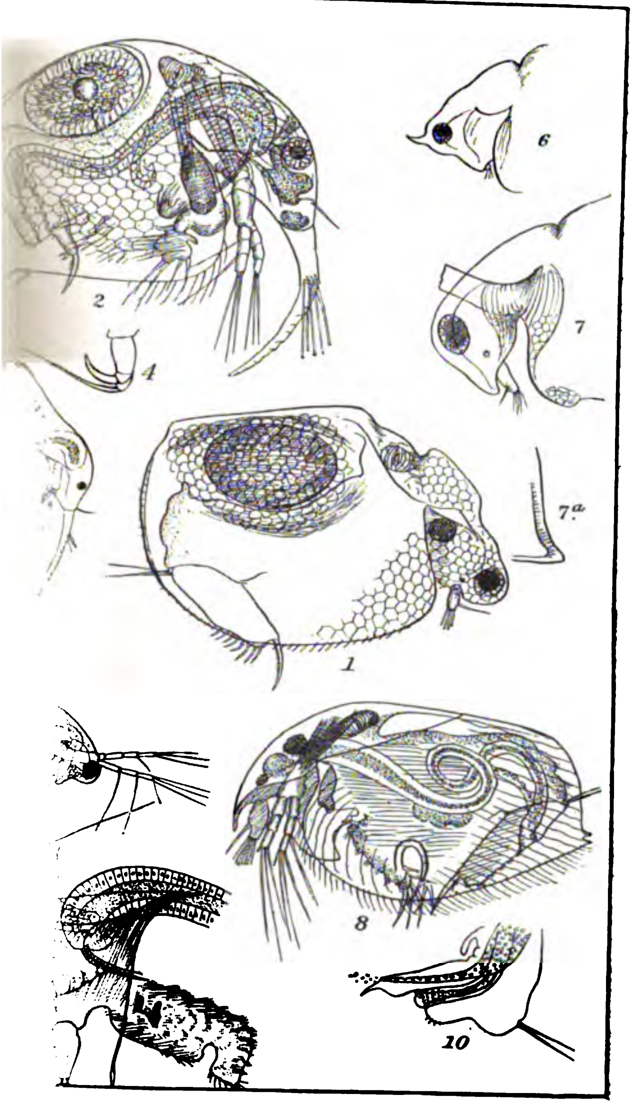

PLATE J.

Fig. 1. *Ceriodaphnia scitula*, (small var.) ephippial female.
Fig. 2. *Bosmina longirostris.*
Fig. 3. *Bosmina lilljeborgii.* After P. E. Mueller.
Fig. 4. *Bosmina*, hook on the first foot of male.
Fig. 5. *Scapholeberis mucronata.*
Fig. 6. *Scapholeberis cornuta*, head.
Fig. 7. *Scapholeberis angulata*, head; 7a. angle of shell.
Fig. 8. *Pleuroxus denticulatus*, male.
Fig. 9. *Simocephalus americanus*, head of female.
Fig. 10. *Bosmina*, post-abdomen of male (after Weismann).

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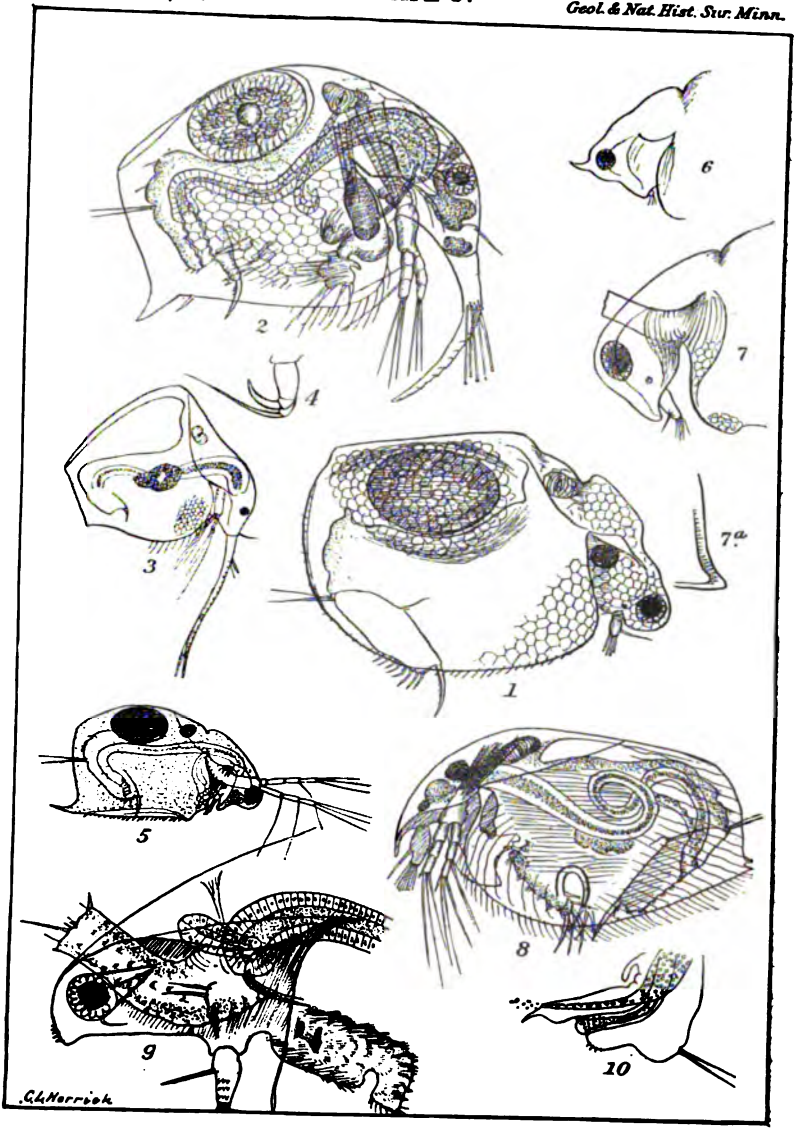

PLATE J^1.

Fig. 1. *Bosmina striata.*
Fig. 2. *Bosmina longirostris.* (See plate J, fig. 2.)
Figs. 3-5. *Bosmina cornuta.*
Figs. 6, 7. *Pleuroxus procurvatus.*
Fig. 8. *Graptoleberis inermis.*
Fig. 10. *Acroperus* sp.
Figs. 11, 12. *Graptoleberis inermis.*

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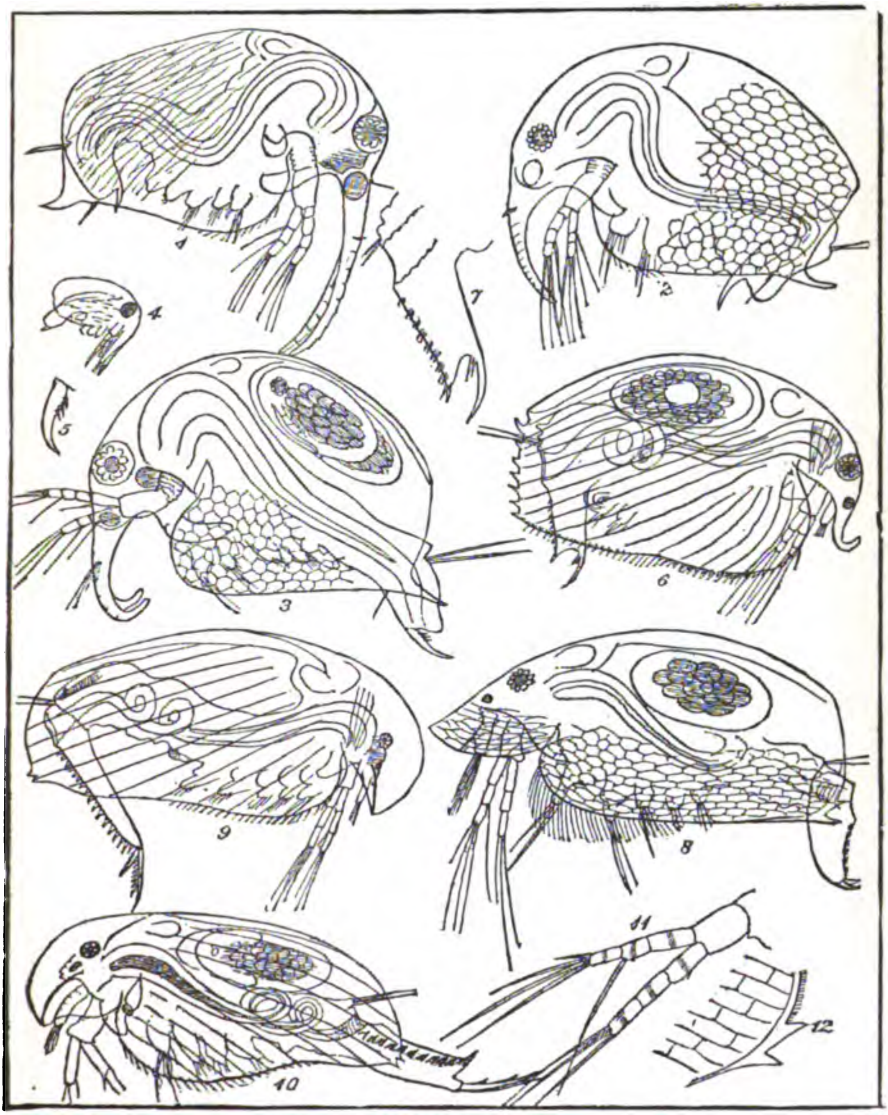

PLATE K.

Fig. 1. *Daphnia minnehaha*, male.
Fig. 2. “ “ part of feet of first and second pair.
Fig. 3. *Canthocamptus hibernicus*, antenna of female.
Fig. 4. “ “ fifth foot of female.
Fig. 5. “ *palustris*, antenna of male.
Fig. 6. “ *trispinosus*, fifth foot of female.
Fig. 7. “ *minutus*, young.
Fig. 8. “ “ nauplius form.
Fig. 9. *Pseudo-sida bidentata*, adult female, antennule, labrum, angle of shell and post-abdomen.
Fig. 10. *Daphnia rosea*, young female.
Fig. 11. “ “ post-imago.
Fig. 12. “ “ beak.

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PLATE K.

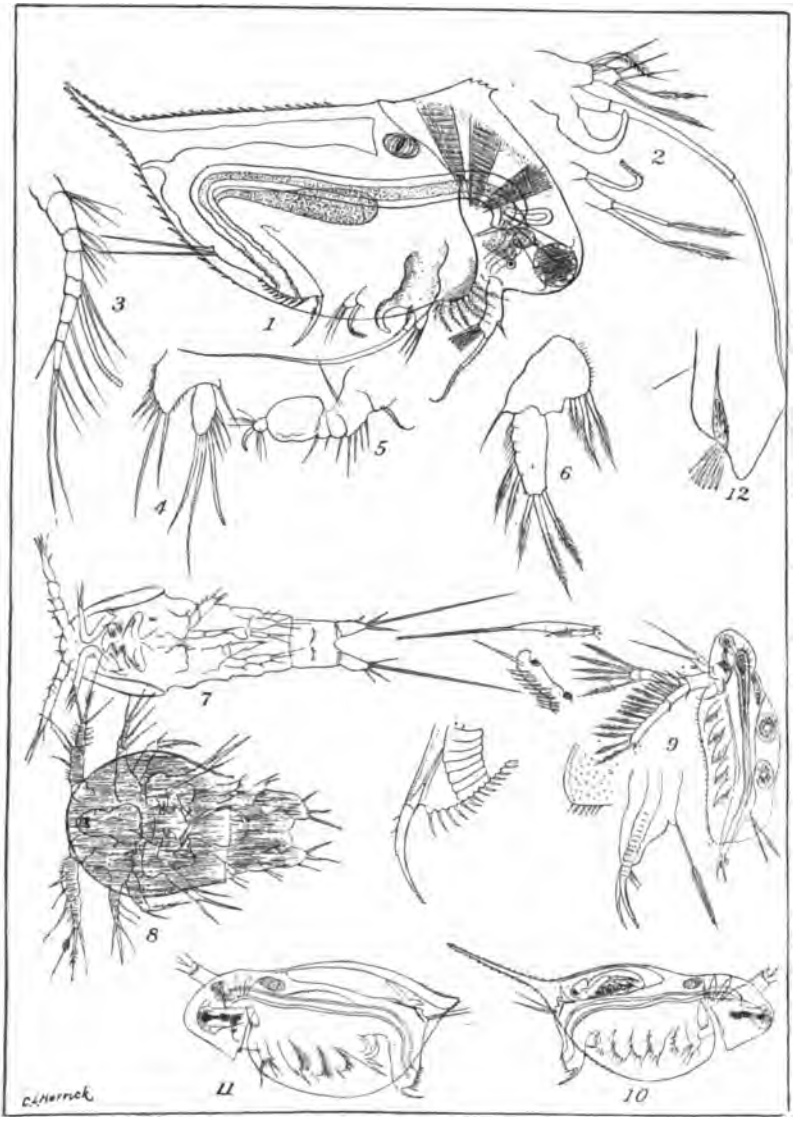

PLATE L.

Fig. 1. *Daphnia minnehaha*, young female.
Fig. 2. " " head of female; 2a. post-abdomen.
Fig. 3. " *hyalina*, young female.
Fig. 4. " " young.
Fig. 5. " " post-imago.
Fig. 7. " *dubia*, young.
Fig. 8. " " older female.

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PLATE L.

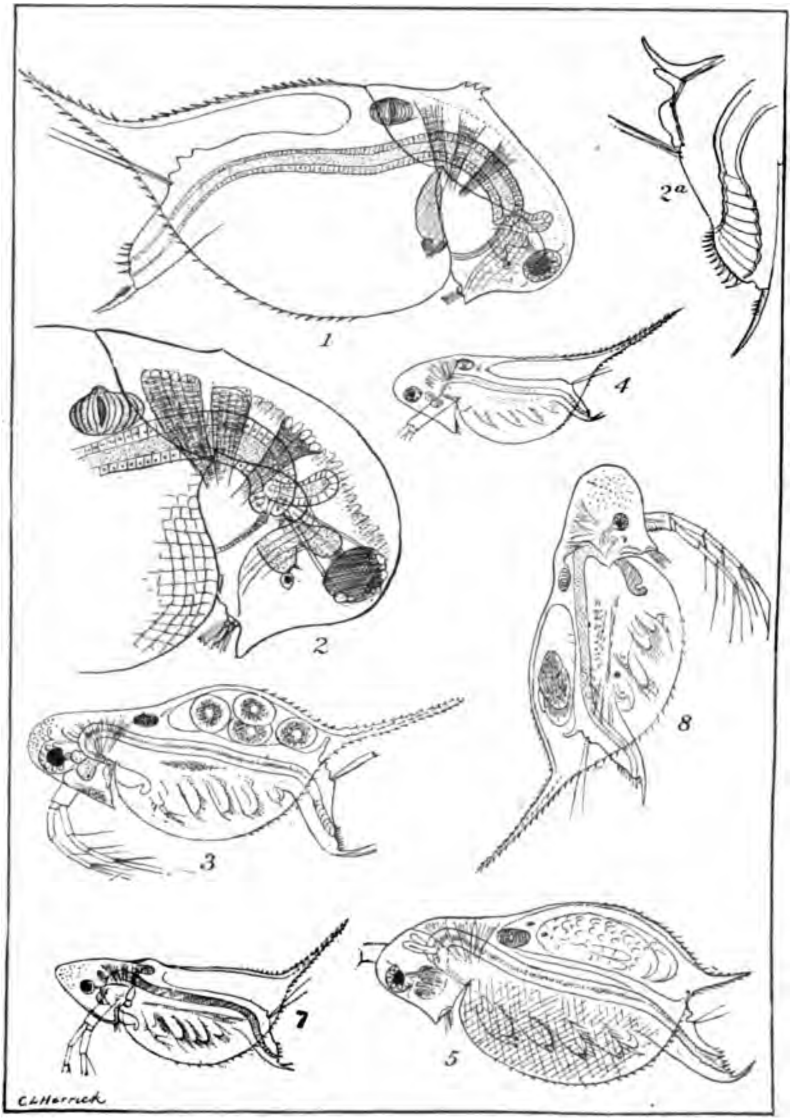

PLATE M.

Fig. 1. *Daphnia schæfferi*, post-abdomen of female.
Fig. 2. " " " " male.
Fig. 3. " " male antennule.
Fig. 4. " " brain and nerves.
inf. œ. g. infra-œsophagal ganglion with nerves to antennæ; œ. œsophagus; n. f. frontal nerve; g. opt. optic ganglion; m. opt. muscles which move the eye; p. f. pigment fleck; n. opt. optic nerve.
Fig. 5. *Daphnia schæfferi*, posterior part of embryo.
Fig. 6. *Eurycercus lamellatus*, heart, showing the anterior bifid portion between the lobes of which is the arterial opening and valve. The vaned arrows represent deeper currents while the unvaned indicate superficial ones. The dotted line represents the position of the pulsating membrane separating the venous from the arterial currents and seen in section at (a).
Fig. 7. *Daphnia similis*, anterior part of the nervous system seen from below. a. optic nerve; b. optic ganglion; c. frontal nerve; d. nerve to antennules; e. commissure connecting upper and lower œsophagal ganglion; f. nerves to antennæ and mandibles.

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PLATE M.

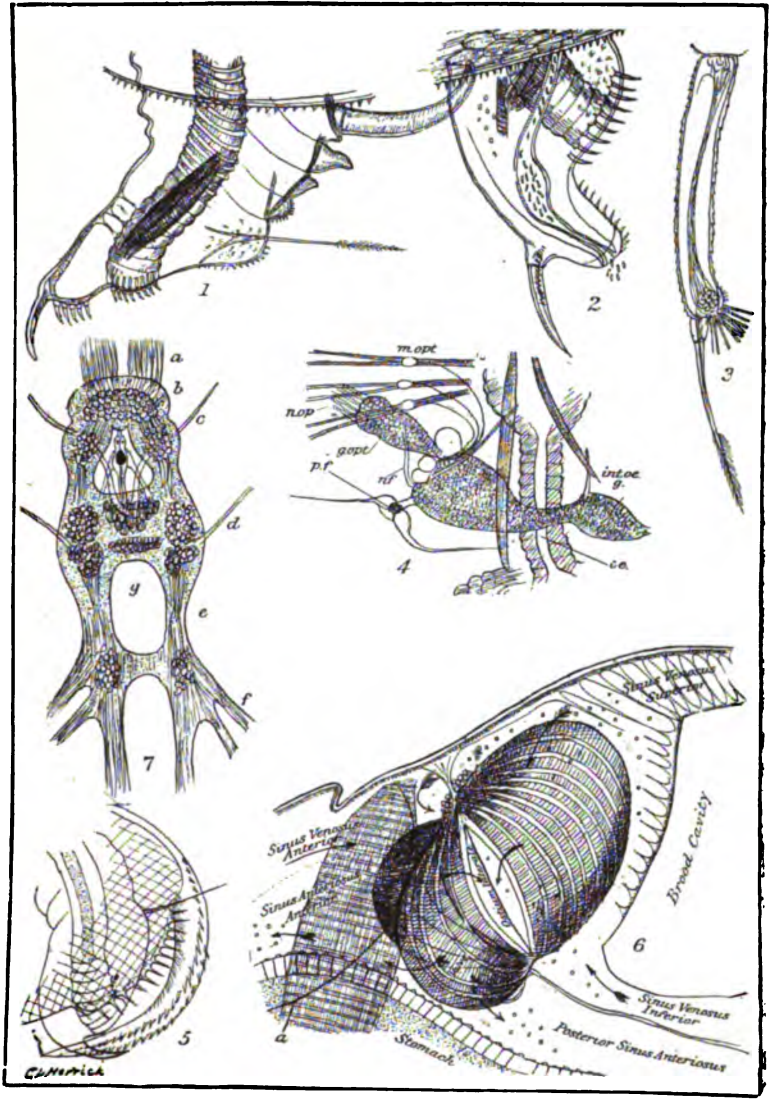

PLATE N.

Fig. 1-4. *Daphnia pulex*, *var. nasutus*.
Fig. 5. outline of head and (a) beak of D. similis.
Fig. 6. *Leptodora hyalina*, seen from above.
Fig. 7. " " larva.
Fig. 8. *Latona setifera*, female.
Fig. 9. *Limnosida frontosa*, female.
Fig. 10. " " antennule of male.
Fig. 11. *Holopedium gibberum*, female.
Fig. 12. *Sida elongata*, head outline.
Fig. 13. *Sida crystallina*, head outline of young female.
Fig. 14. " " antennule of male.
Fig. 15. " " " of female.
Fig. 16. *Daphnia galeata*, outline of head.
Fig. 17. " "*vitrea*" " " "

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PLATE N.

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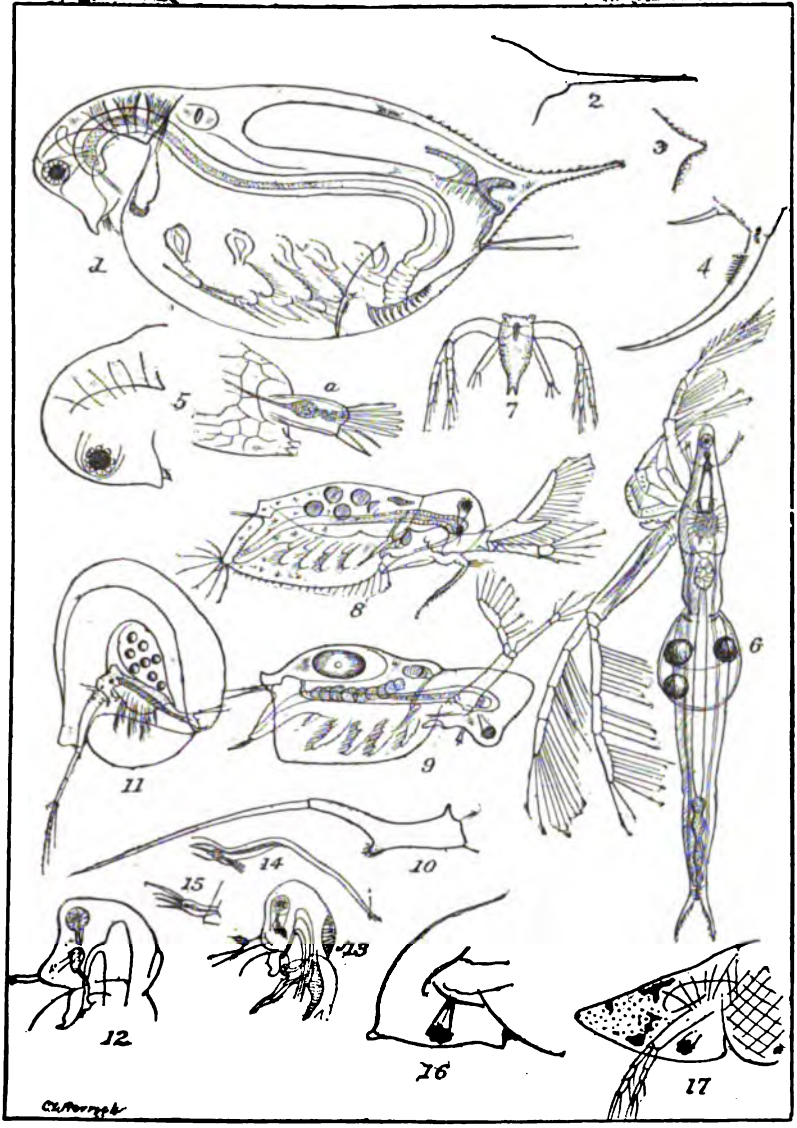

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PLATE O.

Fig. 1. *Canthocamptus illinoisensis*, antenna of female.
Fig. 2. " " fifth foot of female.
Fig. 3. " " antennule.
Fig. 4. " " first foot.
Fig. 5. " " caudal stylet.
Fig. 6. *Canthocamptus northumbricus*, *var. americanus*, fifth foot of female.
Fig. 7. " " antenna of female.
Fig. 8. " " maxilliped.
Fig. 9. " " caudal stylet.
Fig. 10. " " antenna of male.
Fig. 11. " " first foot.
Fig. 12. " " fourth foot.
Fig. 13. " " fifth foot of male.
Fig. 14. " " frontal area.
Fig. 15. *Canthocamptus tenuicaudis*, stylets.
Fig. 16. " " fifth foot of female.
Fig. 17. *Cyclops serrulatus*, fifth foot.
Fig. 18. " " fourth foot.
Fig. 19. " " outer ramus of first foot.
Fig. 20. *Canthocamptus northumbricus*, inner ramus of third male foot.
Fig. 21. " " beak.
Fig. 22. " " maxilla.

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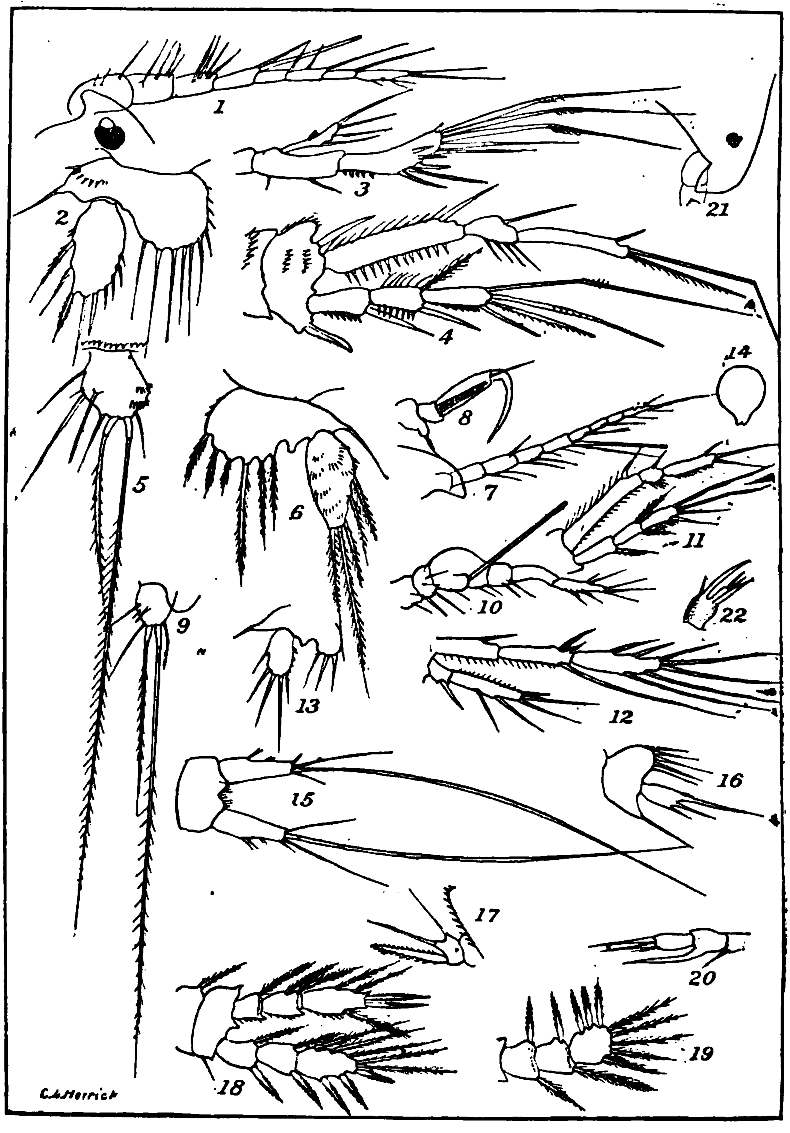

PLATE P.

Fig. 1. Heart of *Simocephalus vetulus*. a, tendons attached to lateral walls of heart. b, venous opening of heart. c, muscular bands supporting the abdomen, connected by transverse bands. d, cells of nutritive matter hiding the arterial opening. e, thin membrane seen in section which separates the venous from the arterial blood currents, is in focus near the side, but its situation in the center is shown by the dotted line. Above this or outside it is the attachment of the powerful antennary and mandibular muscles. f, posterior arterial sinus. g, brood-sac. h, alimentary canal with thick glandular cell walls. i, shell gland or excretory organ. j, powerful muscles supporting and moving the abdomen.

Fig. 2. An early stage of the embryo of *Daphnia schæfferi*. a, anus. n, nutritive globules or fat drops characteristic of the summer embryo. m^1, m^2, outer and inner envelope of the embryo. This is a nauplius stage, but not the first or proper nauplius. The portion darkly shaded is nutritive yolk.

Fig. 3. A well advanced winter embryo of *D. schæfferi*. a, shell growing over the eyes. b. c, inner shell. d. outer shell. e, lateral part of the head. f, antennules. g, labrum. h, mandibles. i, maxilla. j, second maxilla ? k′, l′, m′, n′, branchial appendages of the 2d–5th pairs of feet. represented by k, l. m, n. o, first foot. p. antenna, q, anus and intestine partly completed. s, shell growing out from the maxillary region.

Fig. 4. Older embryo bursting outer shell.

Fig. 5. Egg after extrusion into the brood cavity.

Fig. 6. Head of young embryo. a, lenses in formation. b, eyes appearing as dark flecks. c, shell growing over the head. d, labrum. e, antennule.

Fig. 7. Longitudinal section through an ephippium.

Fig. 8. Vertical section through an ephippial *Daphnia schæfferi*.

Fig. 9. Somewhat oblique section through the ephippium (a, b, c), heart (h), mandibles (m), and labrum (l).

Fig. 10. A vertical section through the ephippium and its egg.

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PLATE P.

Geol. & Nat. Hist. Sur. Minn.

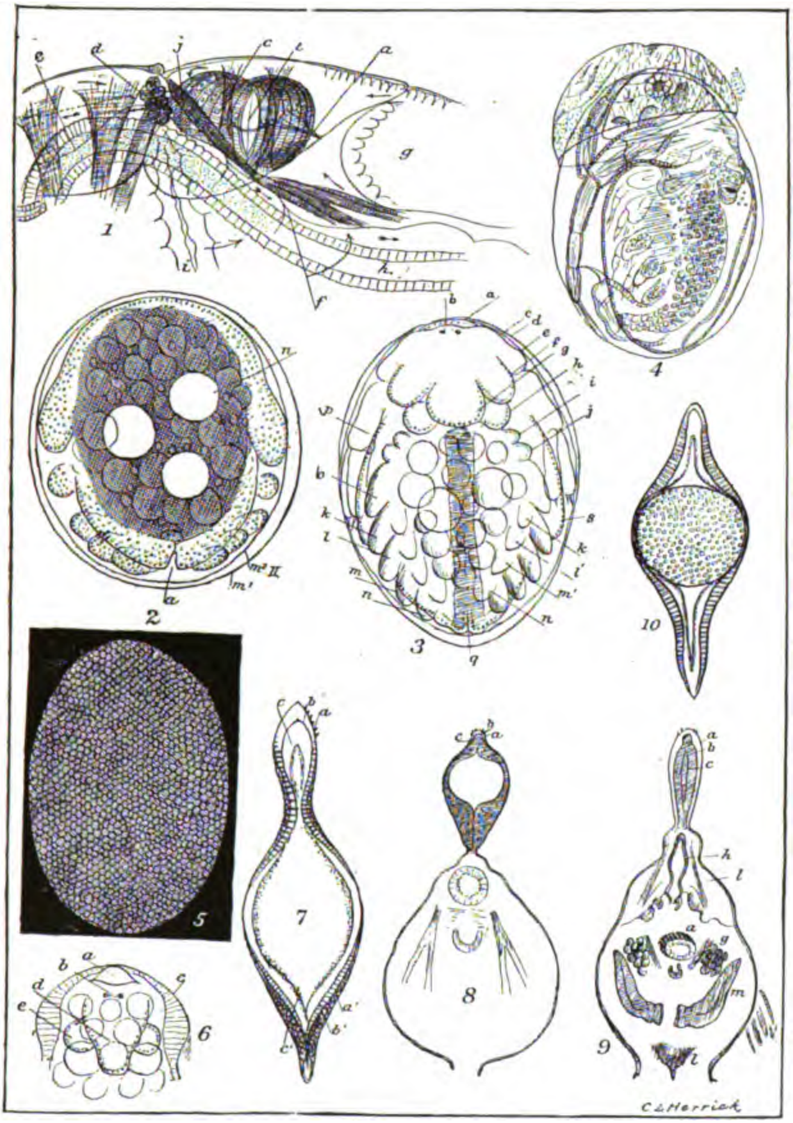

PLATE Q.

Fig. 1. *Alonella pulchella*, female.
Fig. 2. " " reticulations.
Fig. 3. " " post-abdomen.
Fig. 4. *Alona modesta*, male.
Fig. 5. *Diaptomus similis*, female. 5a. jaw.
Fig. 6. " " fifth foot of male.
Fig. 7. " " " " " female.
Fig. 8. " *minnetonka*, fifth foot of male.
Fig. 9. " " " " " female.
Fig. 10. " " abdomen of female.
Fig. 11. " *stagnalis*, margin of last thoracic segment.
Fig. 12. " *sanguineus*, " " " " ' "
Fig. 13. " *stagnalis*, fifth foot of the male.
Fig. 14. *Epischura fluviatilis*, abdomen of male.
Fig. 15. " *lacustris*, fifth feet of male.
Fig. 16. " *fluviatilis*, " " " "
Fig. 17. *Diaptomus pallidus* " " " " inner ramus.
Fig. 18. " *sicilis* " " " " " "

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12th Annual Report PLATE Q. Geol. & Nat. Hist. Sur. Minn.

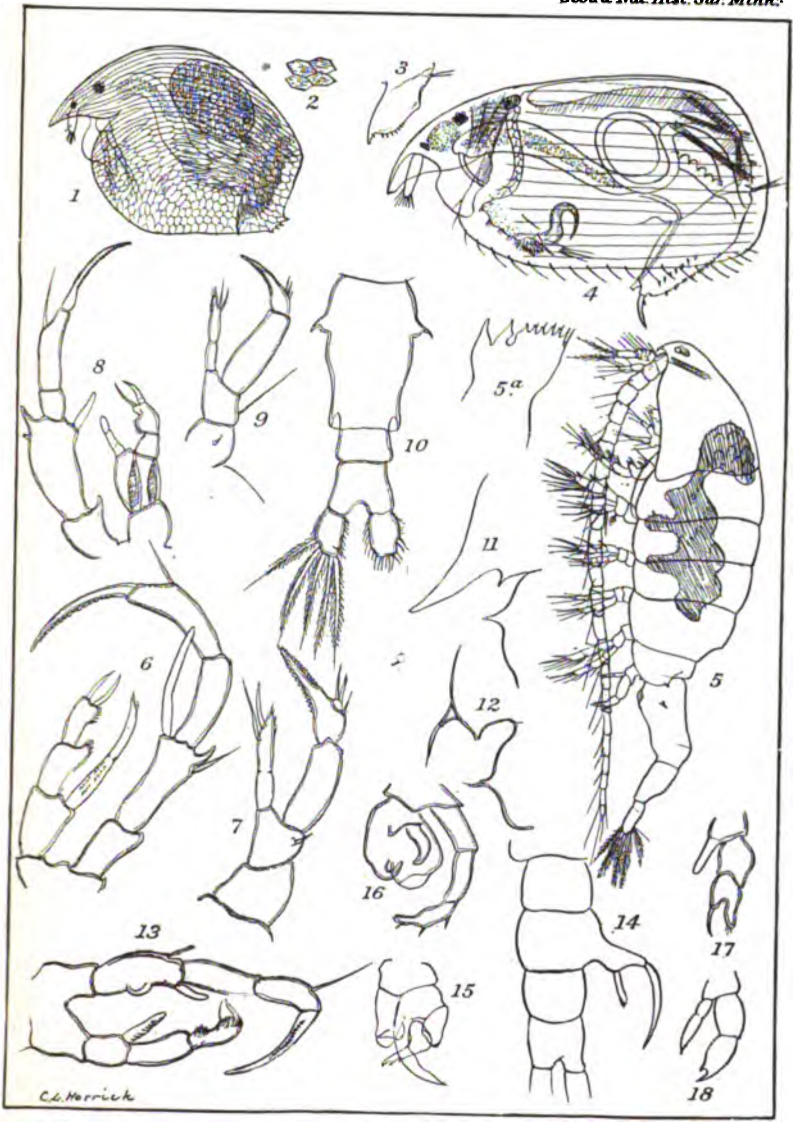

PLATE Q^1.

Fig. 1. *Diaptomus* sp. Young male; external parts as yet but partly developed showing alimentary and reproductive systems as well as a portion of the muscular system. The looped tube is the vas deferens. The small irregularly coiled tube anteriorly is the shell-gland or kidney.

Fig. 2. female with ovary, oviducts and heart.

Figs. 3-4. Nauplius larva of same.

Figs. 5-6. fifth pair of feet of male and female.

Fig. 7. mouth appendages, anteriorly the base of antennæ followed by antennule, labrum, mandible with palp, maxilla and maxilliped.

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From the 10th Annual Report. PLATE Q^1. *Geol. & Nat. Hist. Sur. Minn.*

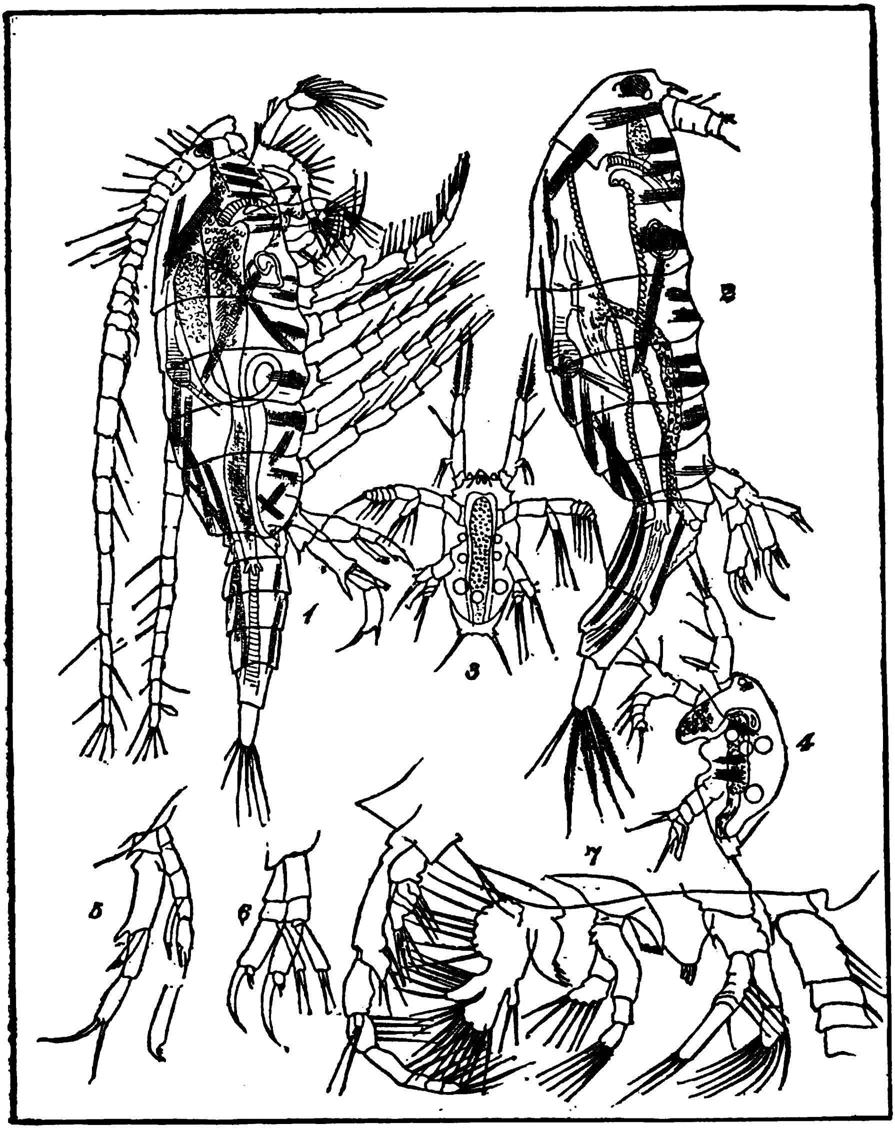

PLATE Q^2.

Fig. 1. *Osphranticum labronectum* (*Potamoichetor*), male.
Fig. 2. antennule.
Fig. 3. maxilliped.
Fig. 4. fifth feet of male.
Fig. 5. palp of mandible.
Fig. 6. end of abdomen.
Fig. 7. feet of first pair.
Fig. 8. eye.
Fig. 13. maxilla.
Fig. 14. mandible.
Fig. 9. *Cyclops ater*, female.
Fig. 10. abdomen.
Fig. 11. maxilliped.
Fig. 12. antenna.

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From the 10th Annual Report. PLATE Q^2. *Geol. & Nat. Hist. Sur. Minn.*

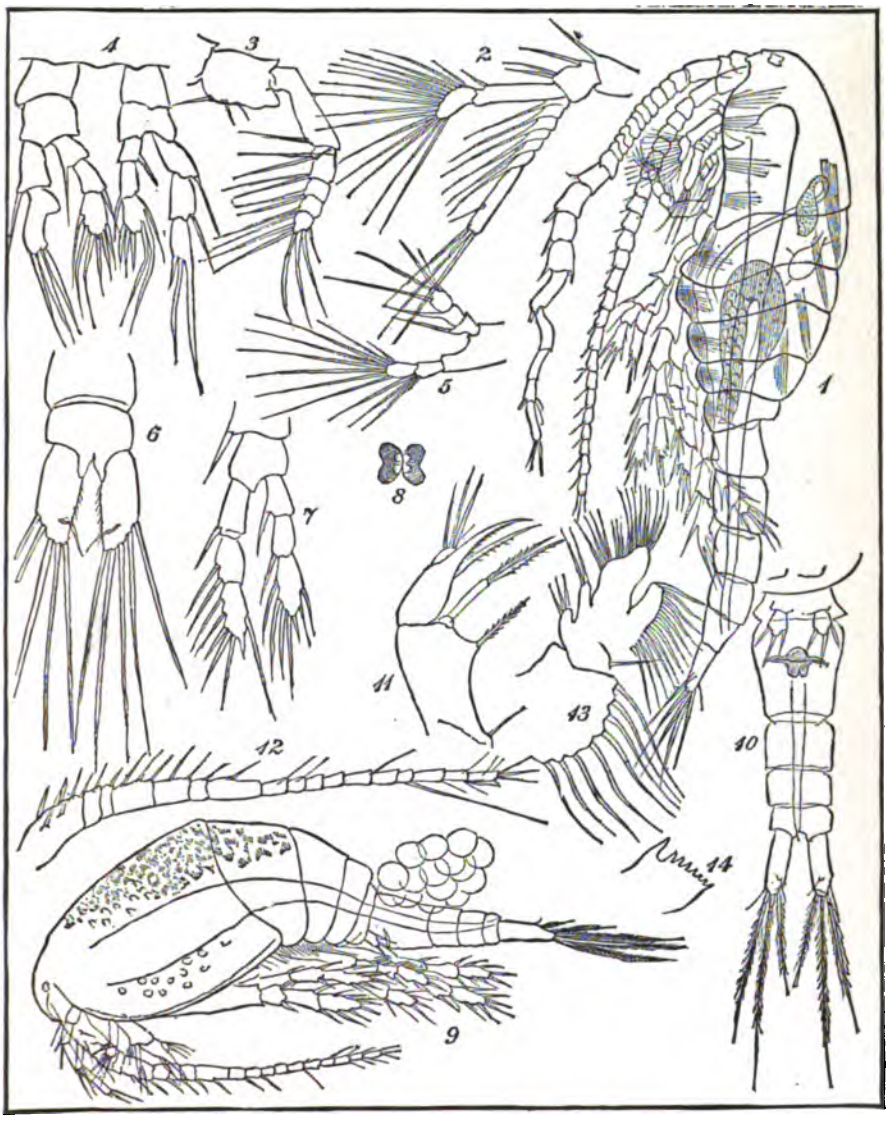

PLATE Q^3.

Fig. 1. *Cyclops ingens,* first segment of abdomen of female.
Fig. 2. antenna.
Fig. 3. fifth foot.
Fig. 4. antenna of young male.
Fig. 5. stylets of mature female.
Fig. 6. stylets of young male.
Fig. 7. maxilliped.
Fig. 8. mandible.
Fig. 9. *Cyclops fimbriatus*, female.
Fig. 10. antenna.
Fig. 11. terminal portion of abdomen.
Fig. 12. female fifth foot.
Fig. 13. second antenna.
Fig. 14. Nauplius form.

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From the 10th Annual Report. PLATE Q3. *Geol. & Nat. Hist. Sur. Minn.*

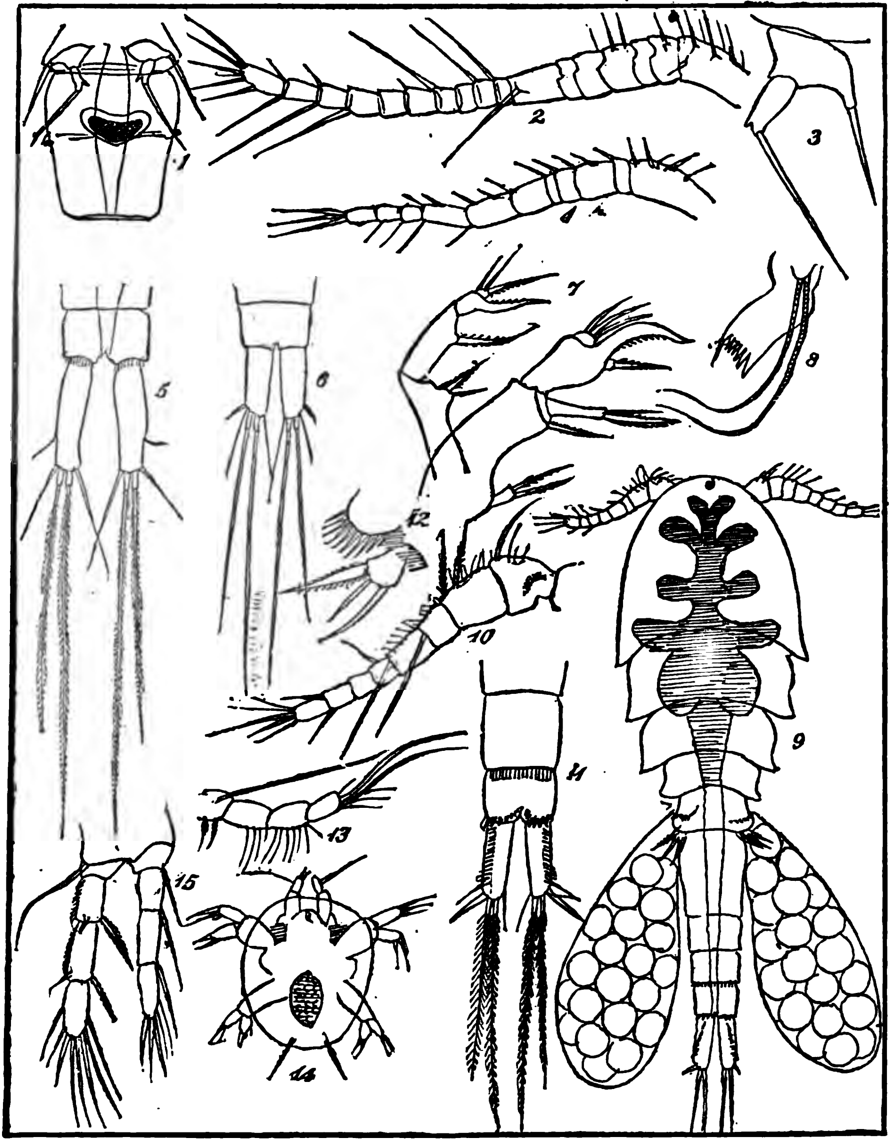

PLATE Q^4.

Fig. 1. *Cyclops tenuicornis*, female.
Fig. 2. mandible.
Fig. 3. maxillæ.
Fig. 4. stylet.
Fig. 5. fifth foot.
Fig. 6. maxillipedes.
Fig. 7. antennæ.
Fig. 8. *Cyclops* "*signatus*," abdomen.
Fig. 9. antenna.
Fig. 10. fifth foot.
Fig. 11. male antenna.
Fig. 12. *Cyclops parcus*, abdomen.
Fig. 13. antenna.
Fig. 14. fifth foot.
Fig. 15. *Cyclops* "*adolescens*," opening of spermatheca and cement gland.
Fig. 16. *Cyclops* "*adolescens*," abdomen.
Fig. 17. foot.
Fig. 18. antenna of female.
Fig. 19. eye.
Fig. 20. antenna of male.
Fig. 21. *Cyclops* "*signatus*," end of antenna.

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From the 10th Annual Report. PLATE Q^{4}. *Geol. & Nat. Hist. Sur. Minn.*

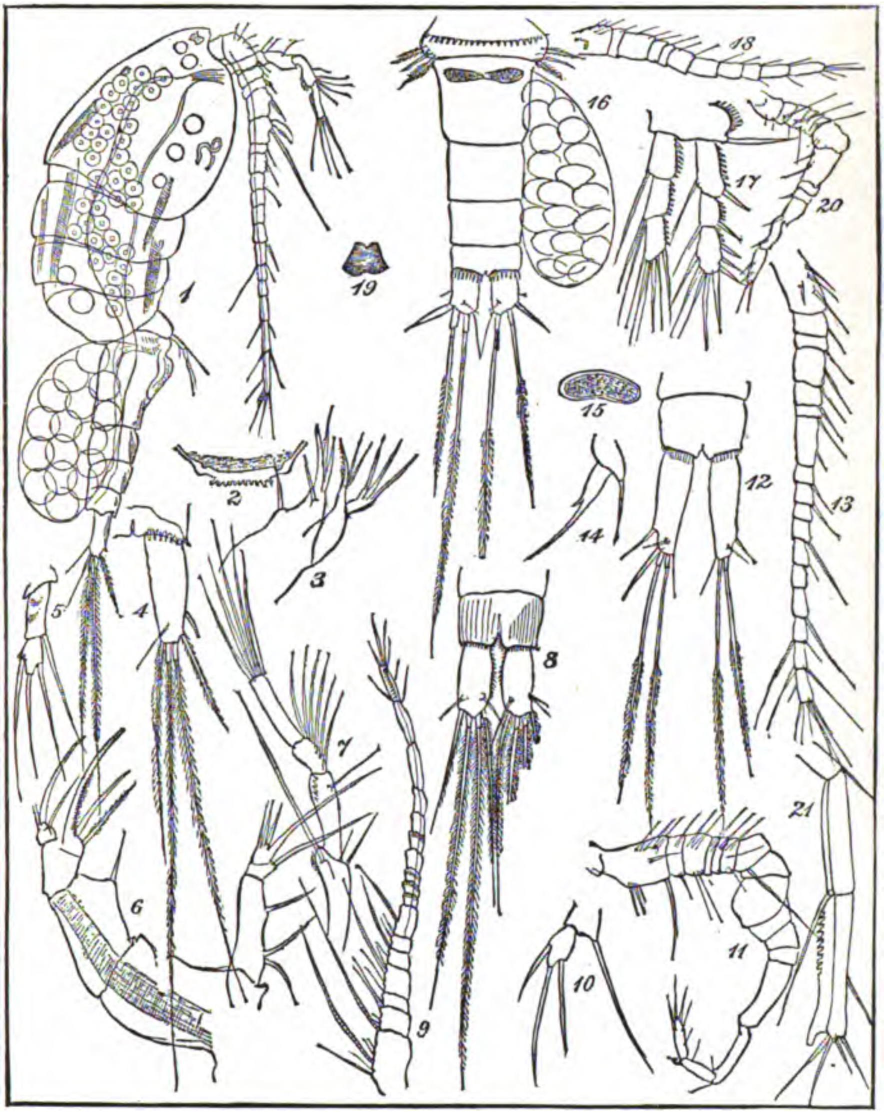

PLATE Q5.

Fig. 1. *Cyclops fluviatilis*, female.
Fig. 2. antenna.
Fig. 3. antenna of young.
Fig. 4. abdomen of young.
Fig. 5. foot of young.
Fig. 6. foot of adult.
Fig. 7. fifth foot.
Fig. 8. eye.
Fig. 10. *C. serrulatus*, young.
Fig. 11. *Daphnella brachyura*, female.
Fig. 12. *Daphnella brachyura*, male.
Fig. 13. edge of valves.
Fig. 14. abdomen of male.
Fig. 15. abdomen of female.
Fig. 16. antenna of male.

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From the 10th Annual Report. PLATE Q^5. *Geol. & Nat. Hist. Sur. Minn.*

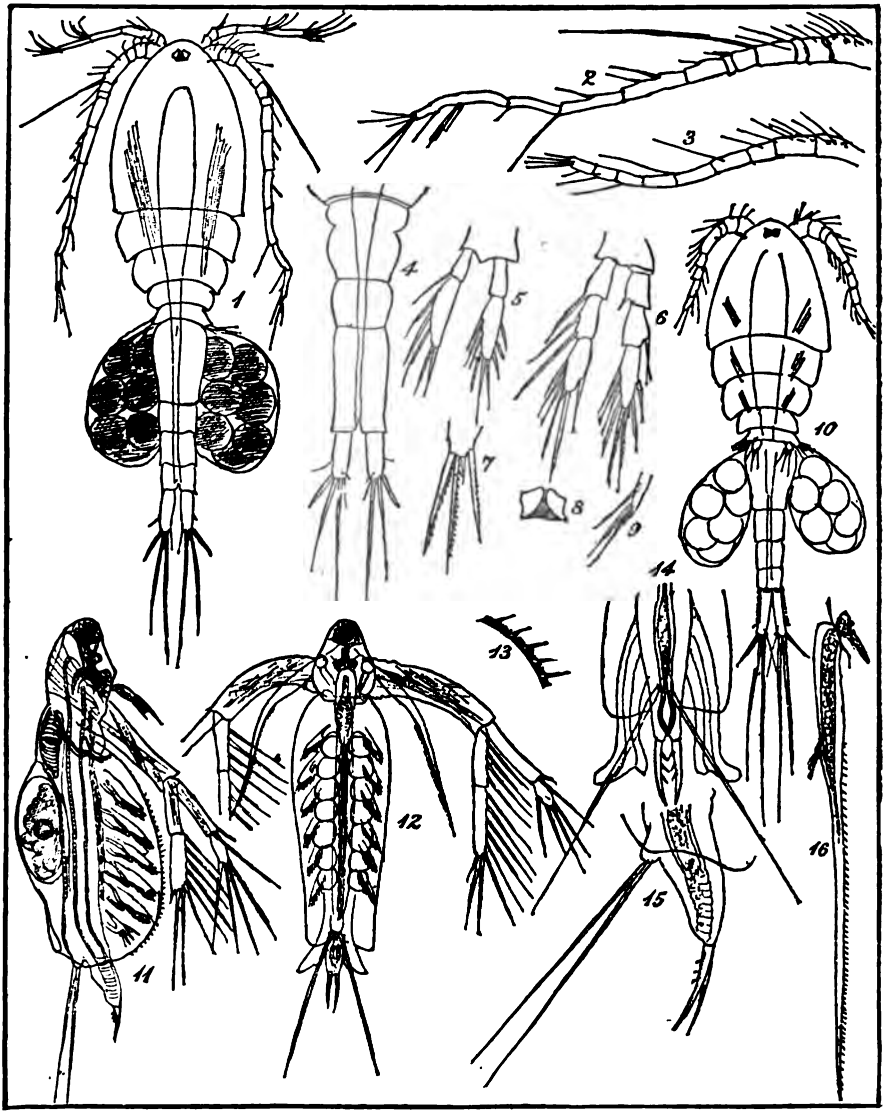

PLATE R.

Fig. 1. *Cyclops modestus.*
Fig. 2. " " end of abdomen.
Fig. 3. " " outer ramus of first foot.
Fig. 4. " " " " " second foot.
Fig. 5. " " fifth foot.
Fig. 6. " *phaleratus*, fourth foot.
Fig. 7. " " outer ramus of first foot.
Fig. 8. " " fifth foot.
Fig. 9. " " caudal stylets.
Fig. 10. " " antenna of young otherwise perfect.
Fig. 11. " *fimbriatus*, end of abdomen.
Fig. 12. " *diaphanus*, abdomen.
Fig. 13. " *ater*, inner ramus of first foot.
Fig. 14. " " outer " " " "
Fig. 15. " " " " " fourth foot.
Fig. 16. " "*signatus*," fourth foot.
Fig. 17. " *ater*, inner ramus of fourth foot.
Fig. 18. " " stylet.
Fig. 19. " *sp.?* first foot.
Figs. 20, 21. " " terminal segments of fourth foot.
Fig. 22. " " fifth foot.
Fig. 23. *Chydorus globosus*, first foot of male.

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12th Annual Report PLATE R. Geol. & Nat. Hist. Sur. Minn.

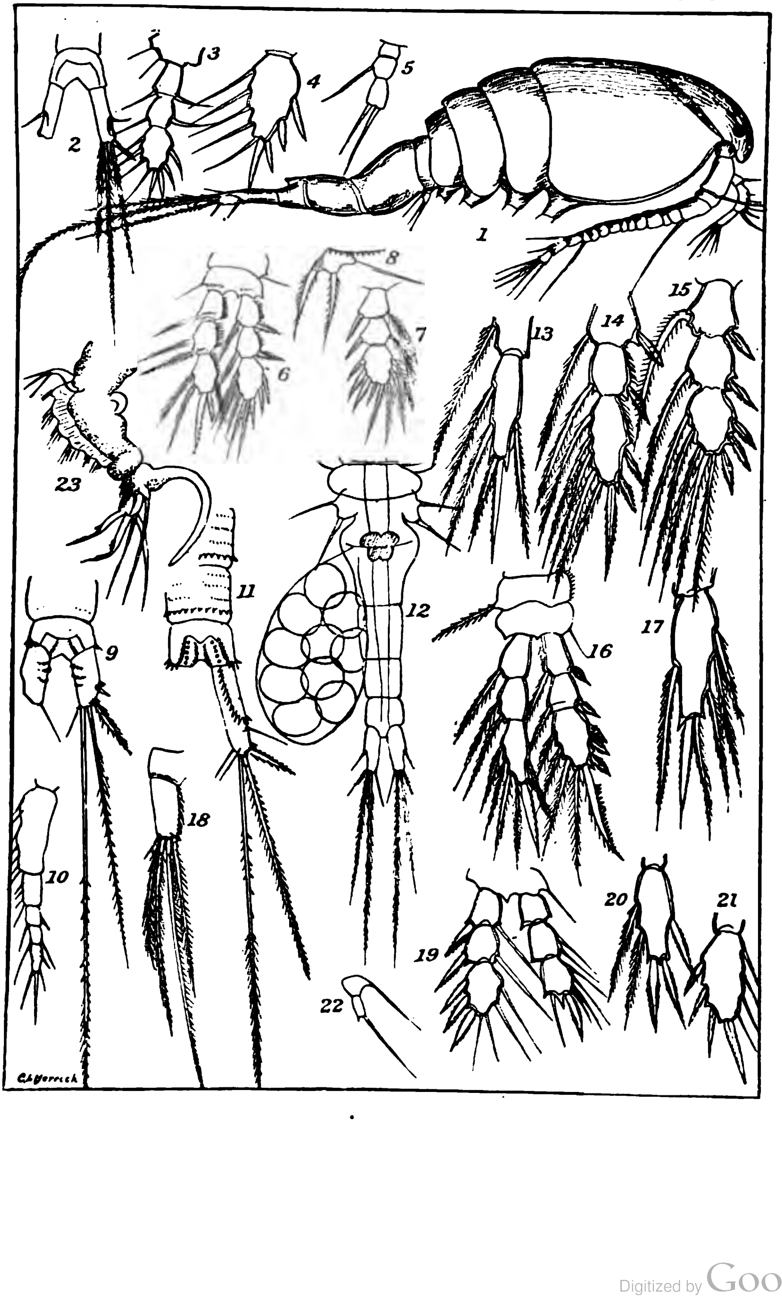

PLATE 8.

Fig. 1. *Ergasilus depressus*, male.
Fig. 2. *Cyclops oithonoides* (Amer. C. tenuissimus, var.), stylets.
Fig. 3. " " fifth foot.
Fig. 4. " " antennules.
Fig. 5. " " fourth feet.
Fig. 6. " " antenna of male.
Fig. 7. " " *brevispinosus*, stylet.
Fig. 8. " " " inner maxilliped.
Fig. 9 " " " swimming foot.
Fig. 10. " " " fifth foot.
Fig. 11. " " " antennule.
Fig. 12. " " " opening of spermatheca.
Fig. 13. *Cyclops sp.?*, nauplius.

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PLATE S.

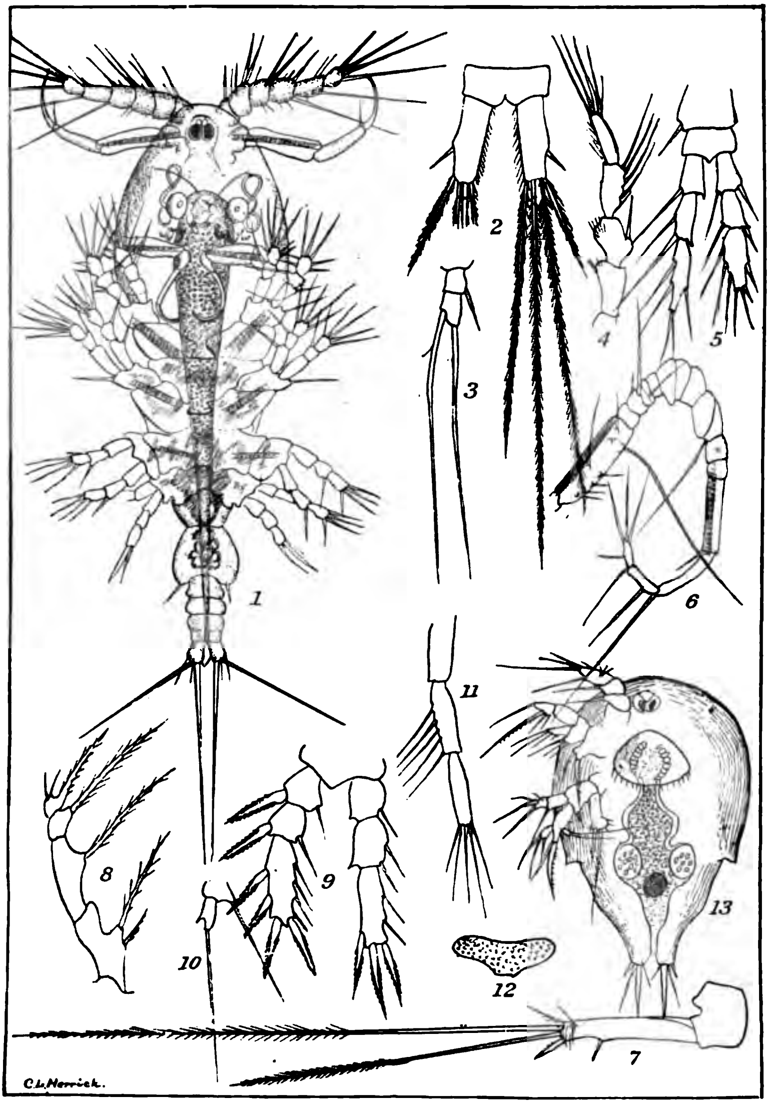

PLATE T.

Fig. 1. *Canthocamptus minnesotensis*, first foot.
Fig. 2. " " stylets.
Fig. 3. " " antenna of female.
Fig. 4. " " fifth foot of female.
Fig. 5. " " " " " male.
Fig. 6. " " antenna of male.
Fig. 7. *Daphnia galeata*, young.
Fig. 8. " " male.
Fig. 9. *Camptocercus leucocephalus*, male.
Fig. 10. *Alonella excisa*, male.
Fig. 11. *Cyclops insignis*, first foot, outer ramus.
Fig. 12. " " fifth foot.
Fig. 13. " " fourth foot.
Fig. 14. " " stylet.
Fig. 15. Worm parasitic in arterial sinus of *Daphnia schœfferi.*

NOTE. On pages 43 and 44, for "Plate T." read Plate J.

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PLATE T.

12th Annual Report *Geol. & Nat. Hist. Sur. Minn.*

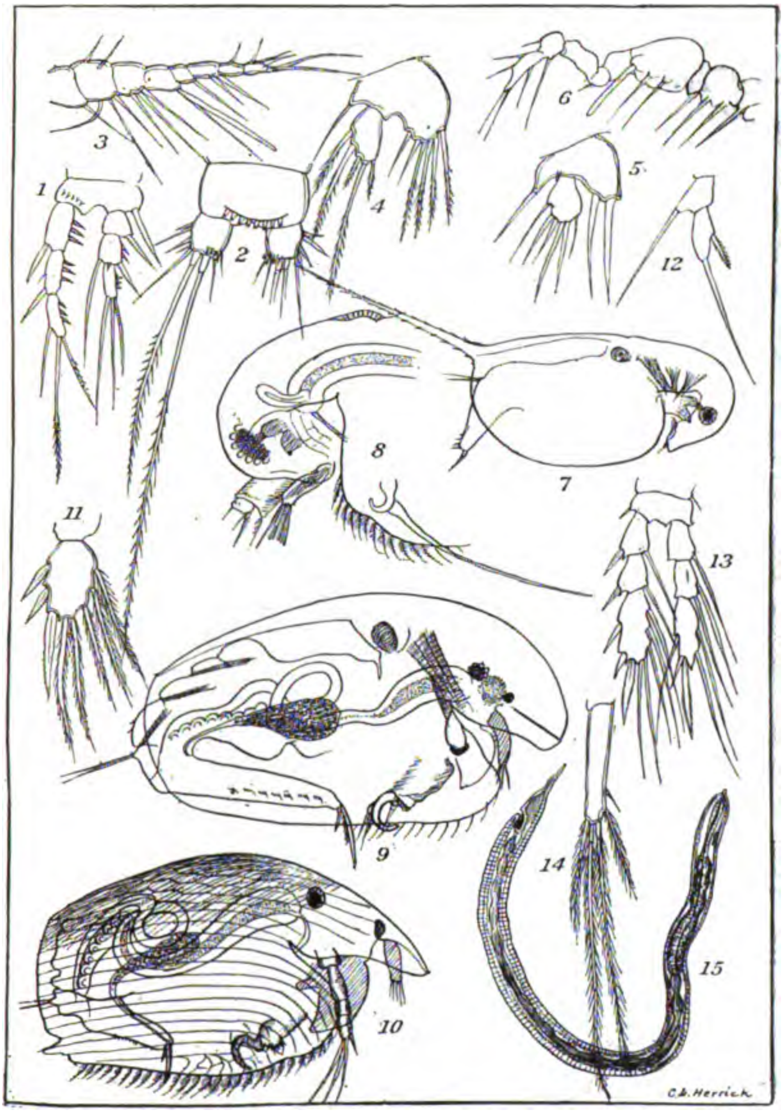

PLATE U.

Fig. 1. *Daphnia kalbergensis*, of moderate size.
Fig. 2. “ “ antennule of male.
Fig. 3. “ “ head of var.
Fig. 4. *Cyclops thomasi*, fourth foot.
Fig. 5. “ “ outer ramus of first foot.
Fig. 6. *Daphnia galeata*, typical form.
Fig. 7. *Cyclops thomasi*, fifth foot.
Fig. 8. “ “ stylet.
Fig. 9. *Cyclops (insectus?)*, fourth foot.
Fig. 10. *Bythotrephes longimanus*, female.
Fig. 11. A curious large protozoan; a. infundibulum frame work b. pulsating vacuole; c. nucleus; d. food and digested matter; e. protective rods; 11a. spicules of the infundibulum.

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12th Annual Report PLATE U Geol & Nat Hist. Sur. Minn.

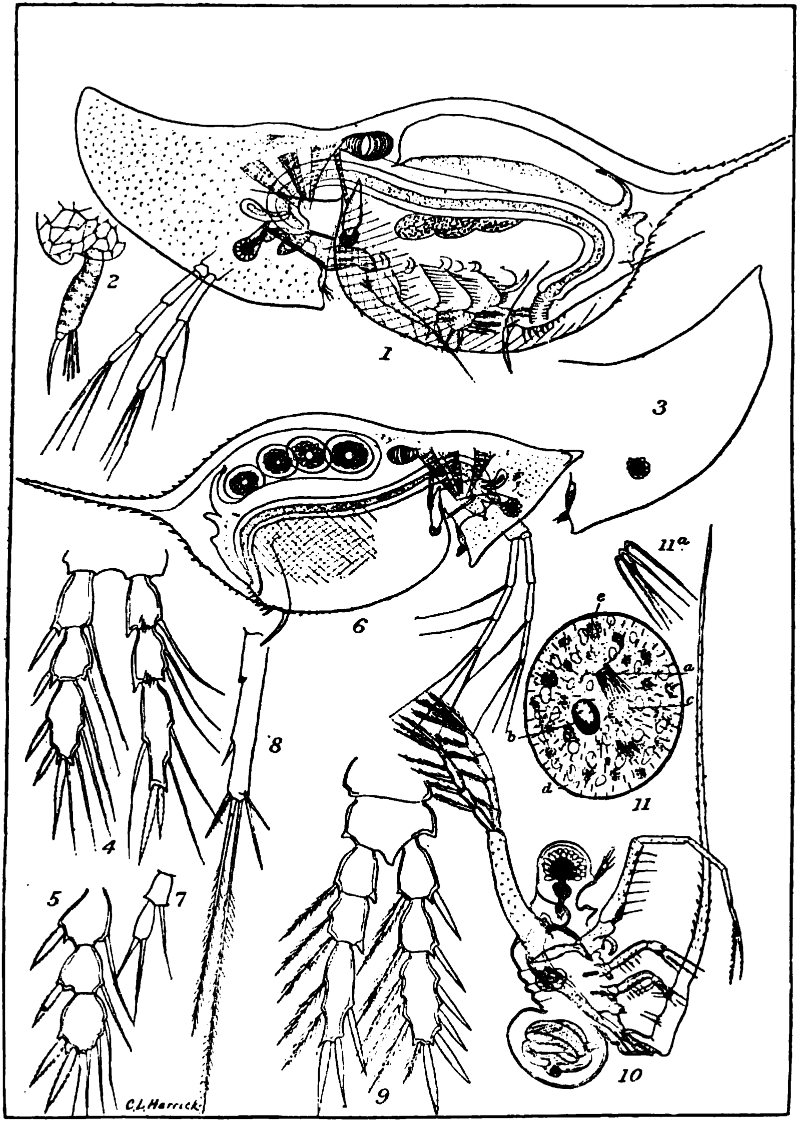

PLATE UI.

Figs. 1-14. *Limnetes gouldii*, Baird.
Fig. 15. *Daphnia magniceps,* female.
Fig. 16. *Daphnia minnehaha*, female.

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From the 10th Annual Report. PLATE U^{1}. *Geol. & Nat. Hist. Sur. Minn.*

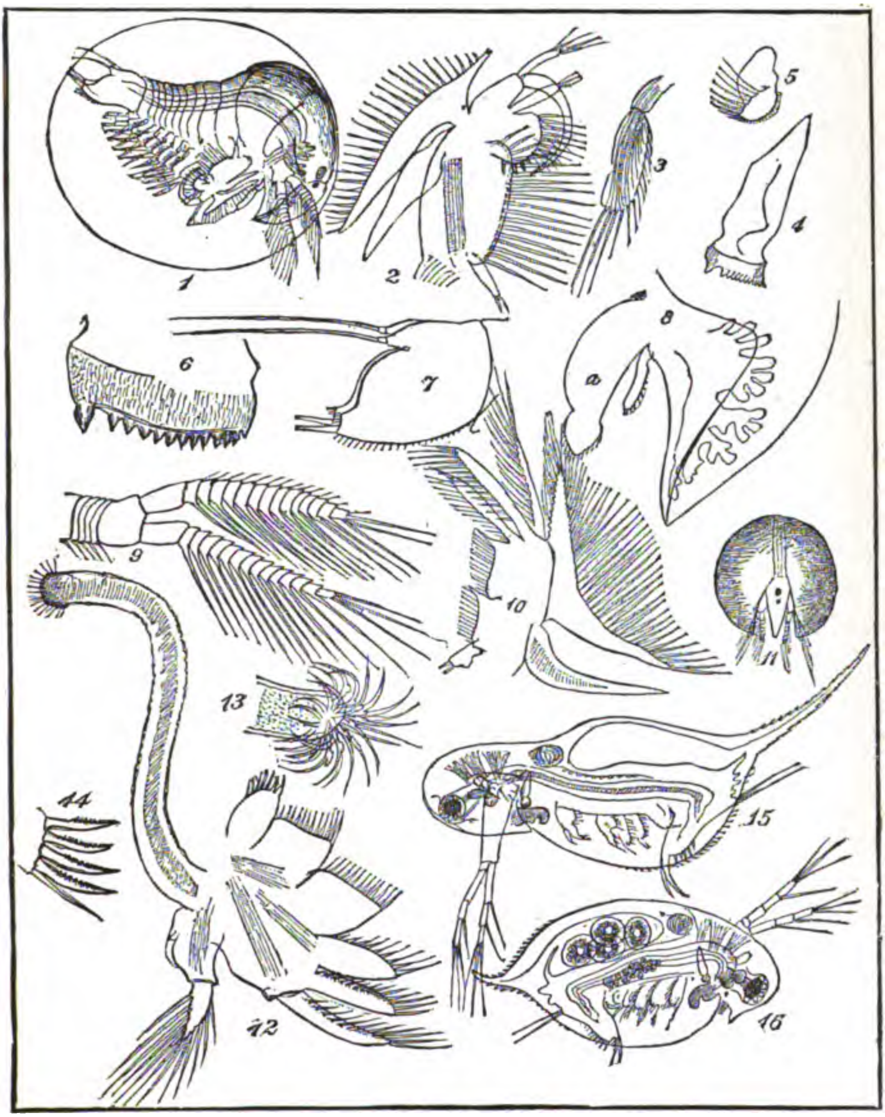

PLATE V.

Fig. 1. *Corethra appendiculata*, head of larva.

Fig. 2. " " portion of heart with its muscles. a. chitinous projection of the body wall to which are attached two muscular threads; b. peripheral muscle; c. proximal muscle attached to the wall of the heart; d. muscles scattered over the surface of the heart, serving as contractors; e. venous opening.

Fig. 3. do., extremity of body.

Fig. 4. do., abdomen of the pupa.

Figs. 5, 6, 7. Rotifera found with entomostraca in Minnesota.

Fig. 8. Flask-shaped rotifer, hermaphrodite, with eggs and sperm. a. jaws and head; b. shell gland; c. glandular portion of the stomach; d. testes; e. œsophagus; f. one of several embryos.

Fig. 9. jaws of the above.

Fig. 10. similar animal, female, deadly enemy to Chydorus.

Fig. 11. jaws of same.

Figs. 12, 13. ? pedicularis, ecto-parasite of *Diaptomus*.

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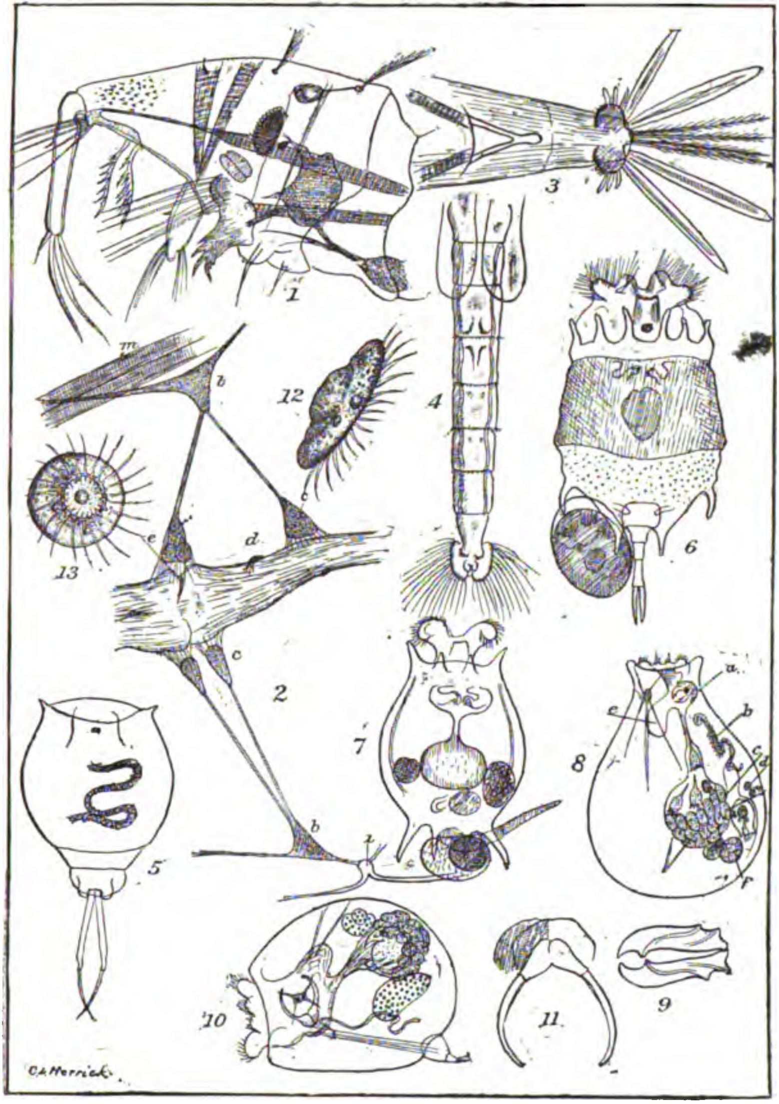
PLATE VI



VI.

BOTANY.

By Warren Upham.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

CATALOGUE

OF THE

FLORA OF MINNESOTA,

INCLUDING ITS

PHÆNOGAMOUS AND VASCULAR CRYPTOGAMOUS PLANTS,

INDIGENOUS, NATURALIZED, AND ADVENTIVE.

BY WARREN UPHAM.

Part VI of the Annual Report of Progress for the Year 1883.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1884.

THE FLORA OF MINNESOTA.

The following catalogue of the plants of Minnesota is presented as a report of progress in this department of the geological and natural history survey of the state. It includes not only the observations of the state geologist and his assistants upon this survey, but also those of earlier botanic collectors and explorers, enumerating all the species that are known to have been found in Minnesota by all observers up to the present time. Grateful mention of the various sources, in chronologic order, from which this list is largely a compilation, is therefore its most appropriate preface.

Hennepin, Carver, Pike, and other early explorers of this state, occasionally refer to some of its forest trees, wild fruits and berries, and plants used for food or medicine by the Indians. Carver, who traveled to the upper part of the Minnesota river in 1767, wrote of the region through which it flows:—"Wild rice grows here in great abundance; and every part is filled with trees bending under their loads of fruits, such as plums, grapes, and apples; the meadows are covered with hops, and many sorts of vegetables; whilst the ground is stored with useful roots, with angelica, spikenard, and groundnuts." On the uplands bordering the river he saw "such amazing quantities of maples, that they would produce sugar sufficient for any number of inhabitants."

The first published list of plants, so far as known to the writer, that includes species found in Minnesota, is in the *American Journal of Science*, vol. iv, 1822, pages 56 to 69, entitled "Notice of the Plants collected by Professor D. B. Douglass, of West Point, in the expedition under Governour Cass, during the summer of 1820, around the Great Lakes and the upper waters of the Mississippi: the arrangement and description, with illustrative remarks, being furnished by Dr. John Torrey." This includes 115 species, 26 of which were from Minnesota.

The appendix of Keating's *Narrative of Major Long's Expedition* in the year 1823, along the Minnesota river and the Red river of the North to lake Winnipeg, and thence by the lake of the Woods and Rainy lake to lake Superior, contains in pages 105 to 123, "a Catalogue of Plants collected in the North-western Territory by Mr. Thomas Say", who accompanied this expedition. These plants were determined and the catalogue prepared for publication by Lewis D. de Schweinitz, excepting the first five species which were by Nuttall. The flowering plants and ferns in this list include 124 species, 30 of which are referred definitely to Minnesota. Both the foregoing lists are arranged according to the Linnæan system.

In Schoolcraft's *Narrative of an Expedition through the upper Mississippi to Itasca lake, in 1832*, pages 160 to 165 are entitled "Localities of Plants collected in the Northwestern Expeditions of 1831 and 1832; by Douglass Houghton, M. D., Surgeon to the Expeditions." The genera in this list are arranged alphabetically, and include 247 species, 115 of which are referred to this state.

Nicollet's report, describing the basin of the upper Mississippi river, from explorations during the years 1836 to 1839, contains in pages 143 to 165, a "Catalogue of plants collected by Mr. Charles Geyer, under the direction of Mr. J. N. Nicollet, during his exploration of the region between the Mississippi and Missouri rivers: by Professor John Torrey, M. D." Of the 446 species in this catalogue, about 60 were collected in Minnesota, most of the others being from Dakota.

Owen's geological report presents in its appendix, in pages 606 to 622, a "Systematic Catalogue of Plants of Wisconsin and Minnesota, by C. C. Parry, M. D., made in connexion with the Geological Survey of the Northwest, during the season of 1848." The author states that "the number of plants comprised in this list is seven hundred and twenty-seven, included in one hundred and six natural orders." Many of them are particularly mentioned as occurring in this state, and often interesting descriptive notes are added, some of which are quoted in the following pages.

The next contribution to our knowledge of the flora of the state is by Mr. Thomas Clark, on the "Botany of the Northeastern Geological District of Minnesota", forming pages 73 to 82 of the report of the state geologist, Aug. H. Hanchett, M. D., in 1865. About a hundred species are here enumerated. Some thirty of them, however, only occur in cultivation, being mostly the common grains and garden vegetables, noted to show the agricultural capability of the region. The other species of this list include chiefly the most important forest trees, and such shrubby and herbaceous plants as seemed of special interest because of their fruit or medicinal qualities, accompanied with remarks respecting the size of the trees, and the abundance and geographical limits of the native species.

The most valuable of all the publications concerning the botany of Minnesota, and the only attempt, before the present, to give a complete list, so far as known, of our flora, was "a Catalogue of the Plants of Minnesota, by I. A. Lapham, LL. D., of Milwaukee, Wis.", which he prepared in 1865. Eight years later, soon after the initiation of the present survey of the state, he generously sent this manuscript to professor Winchell, as state geologist. It was published in the report of the State Horticultural Society for 1875. In the preface, Dr. Lapham states that he had consulted the lists of plants already enumerated from Douglass to Parry; but that his catalogue, nevertheless, rests chiefly upon his "own observations and collections made during several excursions into the State; one of which, in the spring of 1857, was extended to the waters of the Red River of the North." Dr. Lapham refers to his additional sources of information, as follows:—"In 1858 Mr. Robert Kennicott made collections of plants and animals in the Red River country which are preserved by the Northwestern University at Evanston, Illinois. Mr. Charles A. Hubbard collected expressly for me a large number of plants, including mosses and lichens, while on a tour from Lake Superior to Lake Winnipeg and Pembina, as well as while on his return by way of St. Paul. In 1861 Mr. T. J. Hale, while prosecuting geological investigations along the Mississippi river in connection with the Wisconsin State survey, made some collections of plants in Minnesota, a list of which he has kindly furnished to me. Several species are introduced upon his authority." The flowering plants and vascular cryptogams in this catalogue comprise 896 species, besides which it also enumerates 55 species of mosses, liverworts and lichens found in Minnesota. It is without notes, in respect to the part of the state where plants of limited range occur, and does not indicate whether the species are common or rare.

Mr. George M. Dawson's report to the British North American Boundary Commission, on the *Geology and Resources of the region in the vicinity of the Forty-ninth Parallel, from the Lake of the Woods to the Rocky Mountains*, published in 1875, contains in pages 351 to 379, a list of plants collected in this survey during the summers of 1873 and 1874, with notes of their localities and dates of collection, stating whether they were found in flower or in other stages of growth. This enumerates 636 phænogams and vascular cryptogams, of which 289 were collected on the northern border of Minnesota, from the lake of the Woods to the Red river. Twenty-three species of mosses and lichens were also collected on this part of the international boundary. The rushes, sedges and grasses of this list were determined by Prof. John Macoun; by whom, as also by Mr. Dawson, some additional notes respecting their identifications of species and more recent collections in the same region and thence eastward to lake Superior, have been kindly furnished.

Another collection of plants, numbering about 300 species, was made on the same survey, along its extent from the Red river to the Rocky mountains, in connection with the U. S. Northern Boundary Commission, by Dr. Elliott Coues, who submitted them to Prof. J. W. Chickering for determination and report. With these were also incorporated the species of Mr. Dawson's list (excepting mosses and lichens), so far as they were not included in Dr. Coues' collection, making a catalogue of 692 species, besides several varieties; which was published in 1878 in the *Bulletin of the United States Geological Survey*, vol. iv, pages 801 to 830. Ninety-six species are stated to have been found at Pembina, situated on the Red river, adjoining Minnesota.

A few species of Carex, collected by Sir John Richardson at Rainy lake and the lake of the Woods, and determined by Dr. Francis Boott, are included in the botanical appendix of Richardson's *Arctic Expedition in Search of Sir John Franklin*; which also gives much valuable information as to the geographic limits northward of many of our plants.

A list of the ferns of Minnesota, collected by Miss E. W. Cathcart, comprising thirty species and three varieties, was published in 1877 in the *Bulletins of the Minnesota Academy of Natural Sciences*, vol. i, pages 303 and 304. This list includes two especially interesting species, the very rare Phegopteris calcarea, Fée, and Woodsia scopulina, Eaton, which here reaches its eastern limit.

The Report of the Minnesota Horticultural Society for 1884 contains, in pages 83 to 116, a valuable paper by Miss Sara Manning, on "The Wild Flowers of the Lake Pepin Valley", including a catalogue of 504 species.

In the same report, on pages 361 to 367, are "Notes on the Flora of western Dakota and eastern Montana adjacent to the Northern Pacific railroad," by John B. Leiberg, in which are frequent incidental references to Minnesota.

In the annual reports of the present *Geological and Natural Hist-*

ory Survey of Minnesota, notices of the botany of portions of the state have been published as follows:—

In the first annual report, for the year 1872, a "List of Plants, mostly herbaceous, in the neighborhood of St. Anthony, Minnesota; principally found on the University Grounds. 1869—1872. By Professor E. H. Twining." This includes 230 species.

In the report for 1873, lists of the trees and shrubs of the Big Woods, and of Big Stone lake, by Prof. Winchell.

In the report for 1874, lists of the trees and shrubs of Freeborn and Mower counties, by Prof. Winchell.

In the report for 1875, the trees and shrubs of Fillmore county, by Prof. Winchell; and of Olmsted, Dodge and Steele counties, by Prof. M. W. Harrington.

In the report for 1876, the trees and shrubs of Houston and Hennepin counties, by Prof. Winchell.

In the report for 1877, the trees and shrubs of Ramsey county, by Prof. Winchell; and of Rice county, by Prof. L. B. Sperry.

In the report for 1878, pages 35 to 46, "The Plants of the North Shore of Lake Superior. By B. Juni." This is a list, with numerous notes of localities and relative abundance, and occasional descriptive remarks, of 218 species collected by Mr. Juni, in the summer of that year, in connection with the party there engaged in geological exploration; with 58 additional species, collected in the vicinity of the University, at Minneapolis, including 25 species of Carex, while 23 others of this genus are in the list preceding.

In the report for 1879, pages 138 to 149, another list of "Plants of the North Shore of Lake Superior, collected by T. S. Roberts", in connection with the geological survey in that year, from July 26 to Sept. 2; including 220 species, with frequent notes of locality, relative abundance, and other description; 100 of these species being in addition to Mr. Juni's list.

And, in the report for 1880, pages 201 to 216, lists of 76 species of forest trees, 31 shrubs, and 259 herbaceous plants, identified by Mr. O. E. Garrison in the region of the head-waters of the Crow Wing river, the White Earth reservation, Itasca lake, and the upper Mississippi, during an exploration in the summer of that year for the Forestry Department of the United States Census.

Besides these publications, very important contributions of notes and specimens have been received from botanists throughout the state. Mr. John B. Leiberg, of Mankato, supplied a list of about 750 species, collected in 1882, mostly in Blue Earth county, but including also a considerable number from the southwest part of the state. Many specimens collected in Blue Earth county, and others from Dakota and Montana, have been donated by Mr. Leiberg to the State Museum. A list of about 500 species, observed chiefly in the vicinity of Minneapolis by the Young Naturalists' Club, was communicated by Mr. Thomas S. Roberts, by whom nearly all these species were determined, others being by Clarence L. Herrick, F. S. Griswold, and R. S. Williams. I am also indebted to Mr. Roberts for much further assistance in the preparation of the following catalogue. Manuscript lists, to which references are frequently made in stating the geographic range of species or localities of rare or local plants, were received from Mr. George B. Aiton, of Owatonna; Miss Franc E. Babbitt, of Little Falls; Miss F. S. Beane, of Faribault; Mrs. C. H. Bennett, of Pipestone City; Mrs. A. C. Blaisdell, of Saint Cloud; Mr. and Mrs. C. W. Blake, of Cannon River Falls; Miss Eloise Butler, of Minneapolis; Rev. E. V. Campbell, of Saint Cloud; Mrs. M. C. Carter, of Hesper, Iowa; Miss E. W. Cathcart, of Washington, D. C.; Prof. L. W. Chaney, Jr., of Northfield; Mr. R. I. Cratty, of Armstrong's Grove, Iowa; Miss Phebe A. Field, of Stillwater; Mr. Lewis Foote, of Worthington; Mr. O. E. Garrison, of Saint Cloud; Prof. C. J. Gedge, of Moorhead; Mr. H. F. Gibson, of Wabasha; Mr. W. H. Hatch, of Rock Island, Illinois; Dr. V. Havard, surgeon at Fort Pembina, Dakota; Mr. C. L. Herrick, of Minneapolis; Prof. John M. Holzinger, of Winona; Mr. B. Juni, of New Ulm; Mr. J. C. Kassube, of Minneapolis; Dr. and Mrs. H. C. Leonard, of Fergus Falls; Miss Sara Manning, of Lake City; Rev. John Pemberton, of Saint Paul; Mrs. J. W. Ray, of Lake City; Dr. J. H. Sandberg, of Red Wing; Rev. John Scott, of Emerson, Manitoba; Rev. H. M. Simmons, of Minneapolis; Mrs. E. H. Terry, of Saint Paul; and Prof. N. H. Winchell, of Minneapolis. Many observations in respect to the relative abundance and geographic range of species have been also noted by the writer during explorations for this survey.

Though not within the province of this catalogue, it seems desirable to mention here the lists of 775 species of Fungi, by Dr. A. E. Johnson, of Minneapolis, in the *Bulletins of the Minnesota Academy of Natural Sciences*, vol. i. These were nearly all collected by Dr. Johnson within the limits of Hennepin, Ramsey, Wright and Anoka counties. The fifth annual report of this survey, for the year 1876, contains the same, but with the notes somewhat abbreviated, to the number of 558 species, the extent to which the work had been carried at the date of that report. Dr. Johnson has also given much attention to the study of the fresh-water algæ, determining a large number of species.

Another successful student of fresh-water algæ, especially of the Desmids, is Miss Eloise Butler, of Minneapolis. An article respecting these microscopic plants, by Mr. Francis Wolle, in the *Bulletin of the Torrey Botanical Club* for February, 1883 (vol. x, pages 13 to 21), enumerates eighteen species new to the United States, collected by Miss Butler in the vicinity of Minneapolis, including eight forms (three species and five varieties) new to science.

CONDITIONS DETERMINING THE CHARACTER OF THE FLORA.

In considering the botany of any district, its geographic position, elevation and contour, the climate, and the diverse rocks and soils which it presents, need to be briefly stated, since these circumstances control the development of the flora.

Minnesota lies in the middle of the North American continent, almost midway between the Atlantic and Pacific oceans and between the gulf of Mexico and the Arctic ocean, being distant a thousand miles or more from each of these grand bodies of water. The extent of the state from south to north is 380 miles, and its average width about 220 miles. It lies between 43° 30′ and 49° north latitude, and between 90° and 97° west longitude. Its area is 84,286 square miles.

The topographic features of Minnesota may be briefly summed up for its western three-quarters, as being a moderately undulating, sometimes nearly flat, but occasionally hilly expanse, gradually descending from the Coteau des Prairies and from the Leaf hills, respectively about 2000 and 1700 feet above the sea, to half that hight, or from 1000 to 800 feet, in the long flat basin of the Red river valley, and to the same hight along the valley of the Mississippi from Saint Cloud to Minneapolis. The only exceptions to this moderately undulating or rolling and rarely hilly contour, are the southeast part of the state where the Mississippi river and its tributaries are enclosed by bluffs from 200 to 600 feet high, and the northwest shore of lake Superior and the part of the state lying north of this lake and east of Vermilion lake. A very bold rocky highland rises 400 to 800 feet above lake Superior, within from one to five miles back from its shore-line, all along the distance of 150 miles from Duluth to Pigeon point, the most eastern extremity of Minnesota; while farther north are many hill-ranges, 200 to 500 feet higher, mostly trending from northeast to southwest or from east to west.

Lake Superior is 602 feet above the sea. The shore of this lake is the lowest land in Minnesota, while its highest land is the Mesabi range, which, south of Vermilion lake and eastward, is found by Prof. Winchell to exceed 2000 feet above sea-level. Itasca lake, the head of the Mississippi, is about 1500 feet above the sea; and this river at the southeast corner of Minnesota, 620 feet. Professor Winchell estimates the average elevation of the entire state to be approximately 1275 feet above the sea.

Climate is the most important of the factors by which a flora is modified, and this depends chiefly on geographic position, elevation and contour, if a sufficiently large area is taken into account. The warmest days of summer in Minnesota have a temperature of about 90° Fahrenheit, but such days are rare; and the greatest cold of winter is — 30° or sometimes — 40°. The annual precipitation of moisture as rain and snow is from 25 to 30 inches. It is distributed somewhat equally throughout the year; damaging droughts or excessive rains seldom occur. In winter the snow in the south half of the state is commonly about a foot deep during two or three months; but farther north it attains an average depth of two or three feet.

The soil throughout the greater part of Minnesota consists of glacial drift, a mixture of clay, sand, gravel and boulders, clay being the principal ingredient, and boulders being usually infrequent. This deposit has been gathered from diverse formations of granite and gneiss, sandstone, limestone, and shales. Enriched at the surface by the decay of vegetation through centuries, the black soil on areas of the glacial drift has ordinarily a depth of one or two feet, and is very fertile. Other varieties of soil are found in tracts of gravel and sand, also generally quite fertile, which in many places border the large rivers and spread widely upon the region drained by the St. Croix and Crow Wing rivers and the upper Mississippi; in the lower alluvial bottomlands, which are mostly overflowed by the highest water of spring; on the cliffs of sandstone and limestone which border the rivers in the southeast part of the state; and on the hills of granite and crystalline schists north of lake Superior. Each peculiarity of soil affords a congenial location for plants which are absent or can not thrive elsewhere.

FOREST AND PRAIRIE.

The most important and conspicuous contrast presented by the vegetation covering different parts of Minnesota, is its division in forest and prairie. Forest covers the northeastern two-thirds of the state, approximately; while about one-third, lying at the south and southwest, and reaching in the Red river valley to the international boundary, as also the part of this valley farther north to lake Winnipeg, is prairie. The line dividing these areas, having an almost wholly timbered region on its northeast side, and a region on its southwest side that is chiefly grassland, without trees or shrubs, excepting in narrow belts along the larger streams and occasional groves beside lakes, runs as follows. Entering the state from the north about fifteen miles east of Emerson and St. Vincent, it extends south-southeastward to Red Lake Falls, thirty-six miles east of Grand Forks; thence southeast and south, to the east end of Maple lake; thence southwesterly along this lake, and from it south to the Sand Hill river: thence southeasterly to the White Earth Agency; thence southerly, by Detroit and Pelican Rapids, to Fergus Falls, which is situated half-way from the north to the south line of the state; thence southeasterly, in a less direct and regular course, through Douglas, Stearns, Meeker, McLeod and Sibley counties. to the Minnesota river, and along that stream to Mankato and South Bend; thence easterly by Janesville, Waterville and Morristown, to Faribault; thence northerly, turning backward, to Minneapolis and Anoka, the loop thus formed, enclosing Wright, Carver, Scott, Le Sueur, and parts of adjacent counties, being the boundary of the area well known as the Big Woods; thence easterly, passing through Ramsey and Washington counties to Stillwater and Hudson, where it enters Wisconsin.

The Big Woods are principally made up of the following species of trees, arranged by Prof. Winchell in the estimated order of their abundance: white or American elm, basswood, sugar maple, black and bur oaks, butternut, slippery or red elm, soft or silver maple, bitternut, white and black ash, iron-wood, wild plum, June-berry, American crab-apple, common poplar or aspen, large-toothed poplar, tamarack (in swamps), box-elder, black cherry, cottonwood (beside rivers and lakes), water beech, willows, hackberry, paper or canoe birch, yellow birch, white oak, and red cedar. Farther northward white, red and jack pines, black and white spruce, balsam fir and arbor-vitæ are conspicuous in the forest, intermingled with deciduous trees. Its shrubs include prickly ash, smooth sumach, frost grape, Virginian creeper, climbing bitter-sweet, red and black raspberries, choke-berry, prickly and smooth gooseberries, black currant, and species of cornel, wolfberry, honeysuckle, elder, viburnum, and hazel-nut.

The most abundant species of grass found upon the prairies of southwestern Minnesota, are as follows: beard-grass (Andropogon furcatus, Muhl.), commonly here called "blue-joint," Indian grass (Chrysopogon nutans, Benth.), muskit-grass (Bouteloua racemosa, Lagasca), and porcupine grass (Stipa spartea, Trin.), common on land neither very dry nor very moist; another species of beard-grass (Andropogon scoparius, Michx.), and a second muskit-grass (Bouteloua hirsuta, Lagasca), common on dry swells; the fresh-water cord-grass (Spartina cynosuroides, Willd.), in sloughs, making the principal mass of their hay; and rice cut-grass (Leersia oryzoides, Swartz), with the last. The prairies also bear a great variety of flowers, including numerous species of aster, golden-rod, sunflower, blazing-star or button snakeroot, and prairie clover, and the rose, lily, harebell, phlox, gerardia, fringed gentian, and many others. Sometimes the view across miles of the prairie is made yellow and purple by the multitude of sunflowers, blazing-stars, and gerardias.

Limits of Species.

Gradual changes in the flora are observable in crossing the continent either from east to west or from north to south. Many species disappear as the traveler advances, while others, not before present, are met with. A large majority of the plants in the Pacific states are not found east of the Mississippi; and such limitation prevails almost without exceptions between the arctic and tropical zones. The central position of Minnesota therefore makes this a most interesting field for the notation of the limits of species.

Among our forest trees, the white and red pine, arbor-vitæ ("white cedar"), yellow birch, black ash and sugar maple reach their western limit at the east side of the Red river valley.

No tree of exclusively western range extends east into Minnesota, and the only shrubs thus noted are Elæagnus argentea (silver-berry), Œnothera albicaulis and Amorpha microphylla; but about fifty herbaceous plants belonging to the flora of the western plains and the Rocky mountains, and not yet known to occur east of the Mississippi river, are found within our limits. These include species of Ranunculus, Aquilegia, Vesicaria, Linum, Astragalus, Oxytropis, Potentilla, Gaura, Peucedanum, Cymopterus, Gutierrezia, Aplopappus, Grindelia, Lepachys, Helianthus, Gaillardia, Senecio, Troximon, Plantago, Pentstemon, Orthocarpus, Echinospermum, Collomia, Gentiana, Asclepias, Suæda, Comandra, Euphorbia, Allium, Carex, Sporobolus, Aristida, Buchloe, Elymus, and Beckmannia.

A group of species, most notably represented in the pine and heath families, including our three pines, black spruce, balsam fir, tamarack and arbor-vitæ, huckleberry, blueberry, cranberry, snowberry, aromatic wintergreen or checkerberry, Labrador tea, and the clintonia and dwarf cornel, extends through the northeast part of the state to limits approximately coinciding with the Mississippi river, Red lake and the lake of the Woods.

The northern limits of yellow birch, bur oak, sugar maple and basswood here coincide nearly with the international boundary. The red cedar, cottonwood, hornbeam, white, black and red oaks, butternut, bitter-nut or swamp hickory, hackberry, box-elder, frost grape and prickly ash reach their general northern limits in the north half of this state; but several of them, like many herbaceous species of similar range, continue somewhat farther northwestward into Manitoba. The shell-bark hickory, black walnut, red mulberry and Kentucky coffee-tree attain their most northern range in the south half of the state.

The accompanying map shows the portions of Minnesota respectively occupied by forest and prairie, and the approximate limits of many of our trees.*

INTRODUCED PLANTS.

About eight per cent. of the plants growing without cultivation in this state are introduced species, distinguished in the catalogue by being printed in Italics. Most of them are such as follow civilized man, and grow in his cultivated fields and gardens, in spite of all efforts to banish them. Among the most notable introduced weeds in this state may be mentioned mustard, cow-herb and cockle, specially troublesome in wheat-fields; shepherd's purse, purslane, mallow, May-weed, burdock, mullein, pigweeds, tumbleweed, black bindweed, curled or yellow dock, sheep sorrel, hemp, barnyard-grass, and foxtail or pigeon-grass, frequently too plentiful in cultivated ground, about dwellings, by the road-side, or on pasture-land. The ox-eye daisy or white-weed, Canada thistle and cheat or chess are sparingly established, and may become very common bad weeds here, as farther east. It should be added that, besides these immigrants, a considerable number of weeds native to this country are also common, including species of Lepidium, Iva, Ambrosia, Helianthus and Stachys. Up to the present time, only about half as many naturalized and adventive species are known in Minnesota as in the eastern states, the difference being due to the shorter time since the settlement of this state and the proportionately less numerous opportunities for them to gain a foot-hold here.

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*Its method of delineation is similar to that of Dr. Robert Bell's map, recently published by the Geological Survey of Canada, showing the general northern limits of the principal forest trees of Canada.

PRELIMINARY REMARKS ON THE CATALOGUE.

Under each species is a statement whether it is abundant, common, frequent, infrequent, or rare, and whether its geographic range extends throughout the state or to limits which are indicated approximately; or, when the observations are insufficient for such statement, the localities where the species has been noted are mentioned, with the names of the observers.

The arrangement of families, genera and species strictly follows the fifth edition of Gray's *Manual*; and wherever a synonym replaces any name that occurs in the *Manual*, the latter also is given, enclosed by marks of parenthesis.*

The popular names are mostly such as appear in Gray's *Manual* and Wood's *Class-Book*; but in a few instances other names, in general use in this state, and often specially significant, are inserted.

Introduced species are distinguished from the indigenous, as before mentioned, by being Italicized.

For the species of our flora that are not described in Gray's *Manual*, which only included those found east of the Mississippi, descriptions are quoted from other authorities.† The present work thus supplies, with Gray's *Manual*, the means of identifying all the flowering plants and ferns known to occur in Minnesota.

Determinations of numerous difficult species, and notes concerning them, have been kindly supplied by Prof. Asa Gray, Mr. Sereno Watson, Mr. William Boott, Dr. George Engelmann, Mr. M. S. Bebb, Rev. T. Morong, and other specialists; and I am indebted to Dr. George Vasey for the description of the new Aristida basiramea, Engelmann, posthumously published.

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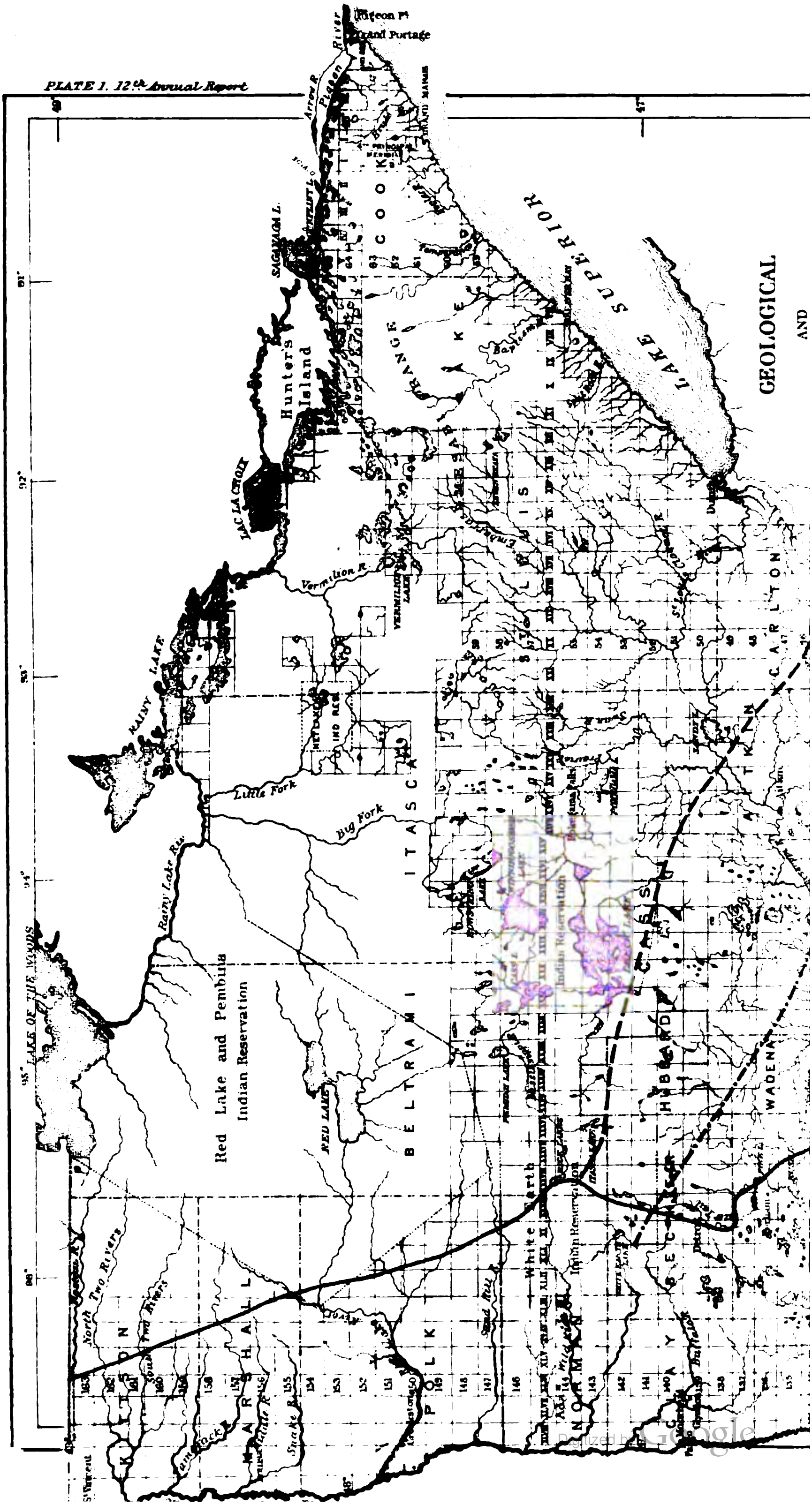
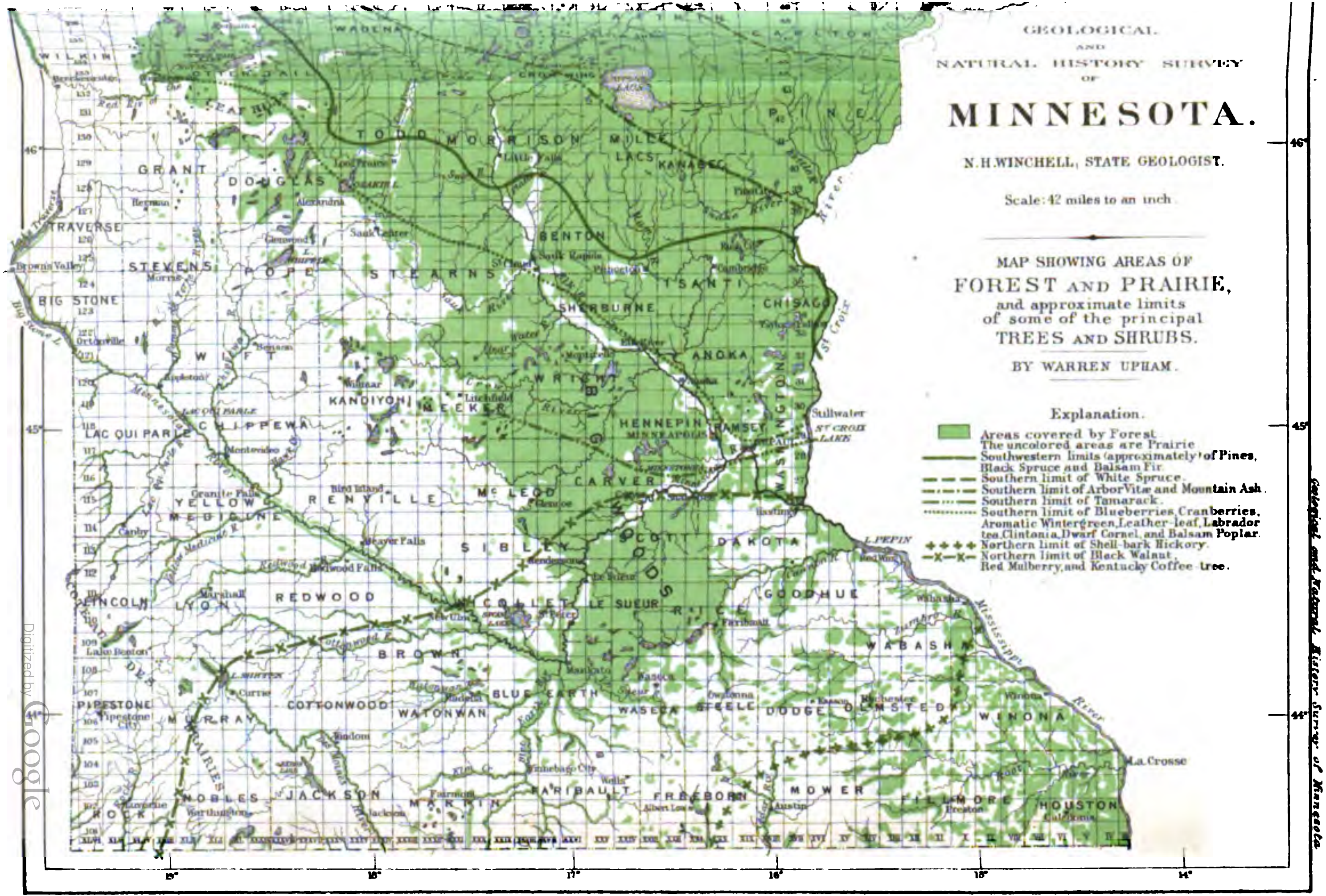
*The sources of improved nomenclature have been Watson's *Bibliographical Index to North American Botany* (Part I; Polypetalæ: 1878); Gray's *Synoptical Flora of North America* (Vol. II, Part I; Gamopetalæ after Compositæ: 1878); various papers by Professor Gray in the *Proceedings of the American Academy of Arts and Sciences;* Bailey's *Catalogue of North American Carices* (1884); Vasey's *Grasses of the United States* (1883); Eaton's *Ferns of North America* (1880); and notes in the *American Naturalist*, the *Botanical Gazette*, and the *Bulletin of the Torrey Botanical Club.*

†Chiefly from Watson's report on the Botany of King's *Exploration of the Fortieth Parallel;* Porter and Coulter's *Synopsis of the Flora of Colorado*; Rothrock's report on the Botany of Wheeler's *Surveys west of the One Hundredth Meridian*; Torrey and Gray's *Flora of North America;* and Gray's *Synoptical Flora.*

PLATE 1. 12th Annual Report





GEOLOGICAL
AND
NATURAL HISTORY SURVEY
OF

MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

Scale: 42 miles to an inch.

MAP SHOWING AREAS OF
FOREST AND PRAIRIE,
and approximate limits
of some of the principal
TREES AND SHRUBS.

BY WARREN UPHAM.

Julius Bien & Co Lith.

CATALOGUE.

RANUNCULACEÆ. CROWFOOT FAMILY.

CLEMATIS, L. VIRGIN'S-BOWER.

C. verticillaris, DC. Virgin's-Bower.

Shady rocks at the head of lake St. Croix, *Parry;* St. Croix Falls, *Miss Field;* lake Pepin, *Miss Manning;* Winona County, *Holzinger.* Rare.

C. Virginiana, L. Common Virgin's-Bower.

Common, or abundant, southward; frequent northward; at Beaver Bay and summit of Black Point mountain north of lake Superior, *Roberts.*

ANEMONE, L. ANEMONE. WIND-FLOWER.

A. patens, L., var. **Nuttalliana**, Gray. Pasque-flower (i. e. Easter-flower). Pulsatilla. "Hartshorn-plant." "Headache-plant." "Gosling." "Prairie Smoke." "Crocus."

Abundant in all the prairie portion of the state. Its bruised leaves have a very pungent smell. This earliest flower of spring has received an unusual variety of popular names.

A. decapetala, L. (A. Caroliniana, Walt.) Carolina Anemone

Frequent in the south part of the state, as in Hennepin, Goodhue, Blue Earth and Pipestone counties; extending north to Saint Cloud, *Campbell, Mrs. Blaisdell,* and Appleton, Swift county, *Miss Elwell.* South.

A. parviflora, Michx. Small-flowered Anemone.

Minneapolis, *Winchell*; upper Mississippi river, *Garrison*; Red river valley, *Gedge.* North.

A. multifida, DC. Many-cleft Anemone Red Wind-flower.

Dayton's bluff, Saint Paul, and between Saint Paul and Fort Snelling, *Miss Cathcart;* lake Superior to the lake of the Woods, *Macoun.* North.

A. cylindrica, Gray. Long-fruited Anemone.

Frequent throughout the state.

A. Virginiana, L. Virginian Anemone.

Common throughout the state.

A. dichotoma, L. (A. Pennsylvanica, L.) Pennsylvanian Anemone.

Common, often abundant, throughout the state.

A. nemorosa, L. Wind-flower. Wood Anemone.

Frequent, or common, throughout the state.

A. Hepatica, L. (Hepatica triloba, Chaix.) Liver-leaf. Round-lobed Hepatica.

Frequent southward, extending north at least to Duluth, *Miss Cathcart*, upper Mississippi river, *Garrison*, and Fergus Falls, *Leonard*.

A. acutiloba, Lawson. (H. acutiloba, DC.) Sharp-lobed Hepatica.

Common southward, extending north to Duluth, *Miss Cathcart*, and Mille Lacs county, *Upham*.

THALICTRUM, Tourn. MEADOW-RUE.

T. anemonoides, Michx. Rue-Anemone.

Often common southward, extending north to Stillwater, *Miss Field*, Anoka county, *Juni*, Stearns county, *Campbell*, and Fergus Falls, *Leonard*. Flowers nearly always purplish. (Abundant at Marine Mills, Washington county, often having more than one row of sepals and occasionally with all the stamens and pistils changed to sepals. *Miss Field*.)

T. dioicum, L. Early Meadow-Rue.

Common, or frequent, throughout the state.

T. purpurascens, L. Purplish Meadow-Rue.

Common, extending north at least to Morrison county, *Upham*, the St. Louis river, *Mrs. Herrick*, and in the Red river valley to Pembina, *Chickering*. (Specimens collected by *Prof. Gedge* at Glyndon, Clay county, have the shining upper surface of the very large leaflets waxy, as if varnished, but the lower surface minutely pubescent or glabrous, not waxy.)

T. Cornuti, L. Tall Meadow-Rue.

Common, or frequent, throughout the state.

RANUNCULUS, L. CROWFOOT. BUTTERCUP.

R. aquatilis, L., var. **stagnatilis,** DC. (R. divaricatus, Gray's *Manual*.) Stiff Water-Crowfoot.

Ponds near Mankato, *Leiberg;* Minneapolis, *Roberts, Herrick;* Stearns county, *Upham;* Alexandria, *Mrs. Terry*. Infrequent.

R. aquatilis, L., var. **trichophyllus,** Chaix. Common White Water-Crowfoot.

Frequent throughout the state.

R. multifidus, Pursh. Yellow Water-Crowfoot.

Common throughout the state.

R. ambigens, Watson. (R. alismæfolius, in *Manual*.) Water Plantain Spearwort.

Stearns county, *Campbell*. Infrequent. North.

R. Flammula, L. Small Spearwort.

Minneapolis, *Roberts*. Rare.

R. Flammula, L., var. **reptans,** Meyer. Creeping Spearwort.

Stillwater, *Leonard;* Minneapolis, *Roberts;* Anoka county and New Ulm, *Juni;* lake of the Woods, *Dawson*. Frequent.

R. Cymbalaria, Pursh. Sea-side Crowfoot.

Common, or frequent, throughout the state, excepting southeastward. Grand Portage, lake Superior, also at New Ulm (common), *Juni;* Little Rock, upper Minnesota river, *Parry;* Nicollet county, *Aiton;* Stearns county, and the Red river valley (common), *Upham;* Fergus Falls, *Leonard;* Worthington (common), *Foote*.

R. affinis, R. Br.* Rough-fruited Crowfoot.

Lake of the Woods, *Dawson*. Northwest.

R. affinis, R. Br., var. **cardiophyllus,** Gray.†

In the Red river valley at Pembina, *Chickering*. West.

R. rhomboideus, Goldie. Rhomboid-leaved Crowfoot. Dwarf Buttercup.

Frequent, or common, throughout the state.

R. abortivus, L. Small-flowered Crowfoot.

Frequent, or common, throughout the state.

R. abortivus, L., var. **micranthus,** Gray.

Minneapolis, *Winchell;* Pipestone county, *Mrs. Bennett*. Infrequent.

R. sceleratus, L. Cursed Crowfoot.

Frequent, or common, throughout the state.

R. recurvatus, Poir. Hooked Crowfoot.

Frequent throughout the state; reaching its northwestern limit at the lake of the Woods, *Macoun*.

R. Pennsylvanicus, L. Bristly Crowfoot.

Common throughout the state.

R. fascicularis, Muhl. Early Crowfoot.

Frequent, or common, throughout the south half of the state; infrequent northward.

R. repens, L. Creeping Crowfoot.

Abundant throughout the state.

R. repens, L., var. **hispidus,** Torr. & Gray.‡ (R. hispidus, Michx.)

Red river valley near Saint Vincent (in a swamp), *Dawson;* common from Manitoba westward, *Macoun*.

R. bulbosus, L. *Bulbous Crowfoot* or *Buttercups*.

Northfield, *Chaney;* Minneapolis, *Mrs. Terry*. Rare.

R. acris, L. *Tall Crowfoot* or *Buttercups*.

Infrequent, but noted at many places, as Lake City, Faribault, Northfield, Minneapolis, Northern Pacific Junction, Carlton county, and on the upper Mississippi river. "Becoming common in the eastern part of Manitoba," *Macoun*.

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*RANUNCULUS AFFINIS, R. Br. Radical leaves petioled, usually pedately multifid; cauline ones subsessile, digitate, with broadly linear lobes; stem erect, few-flowered; carpels with recurved beaks, in oblong cylindrical heads; more or less pubescent throughout. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

†R. AFFINIS, R. Br., var. CARDIOPHYLLUS, Gray. Hirsutely pubescent, radical leaves round-cordate, undivided or many-cleft; cauline ones palmately many-cleft; flower 1 inch in diameter. *Porter and Coulter's Flora of Colorado.*

‡RANUNCULUS REPENS, L., var. HISPIDUS, Torr. & Gray. Stem erect, 1½ to 2 feet high, branching and, with the petioles, very pilose with spreading hairs; leaves trifoliate; leaflets distinctly petiolulate, oval, acute, laciniate; pedicels with the pubescence appressed; flowers as large as in *R. acris;* calyx appressed; carpels smooth, pointed with a very short style. *Torrey and Gray's Flora of N. A.*, vol. i, pp. 22 and 658.

ISOPYRUM, L. ISOPYRUM.

I. biternatum, Torr. & Gray. False Rue-Anemone.

Frequent, or common, throughout the south half of the state; extending north at least to Fergus Falls, *Leonard*

CALTHA, L. MARSH MARIGOLD.

C. palustris, L. Marsh Marigold. "Cowslip."

Abundant, or common, throughout most of the state; less frequent westward.

COPTIS, Salisb. GOLDTHREAD.

C. trifolia, Salisb. Three-leaved Goldthread.

Common northward; extending south to Minneapolis, *Roberts*, and Lake City (rare), *Miss Manning*.

AQUILEGIA, Tourn. COLUMBINE.

A. Canadensis, L. Wild Columbine. "Honeysuckle."

Common, or frequent, throughout the state.

Found, according to *Miss Babbitt*, with white flowers during several years in the south edge of the village of Little Falls, Morrison county, not associated at that locality with the usual type; also some with flowers clear white, others cream-colored, and yet others of the ordinary kind, all growing together west of the Mississippi river, opposite to Little Falls, and likewise near Fort Ripley, in the same county.

A. brevistyla, Hook.* Short-styled Columbine.

In the Red river valley at Pembina, *Chickering*. West.

DELPHINIUM, Tourn. LARKSPUR.

D. exaltatum, Ait. Tall Larkspur.

Frequent through the south half of the state; extending north to the upper Mississippi river, *Garrison*, and Fergus Falls, *Leonard*.

D. tricorne, Michx. Dwarf Larkspur.

St. Paul, *Miss Cathcart*; Pipestone county, *Mrs. Bennett*. Infrequent. South.

D. azureum, Michx. Azure Larkspur.

Common southward; extending north to the upper Mississippi river, *Garrison*, and Manitoba, *Macoun*.

D. Consolida, L. Field Larkspur.

Rarely adventive. Minneapolis, *A. W. Jones*.

HYDRASTIS, L. ORANGE-ROOT.

H. Canadensis, L. Orange-root. Yellow Puccoon.

Stearns county, *Garrison*. Rare. Southeast.

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*AQUILEGIA BREVISTYLA, Hook. Stems low, 6 to 8 inches high, spreading; leaves bi-ternate; leaflets 3-lobed, crenate, 6 to 9 lines [twelfths of an inch] long, crenatures ovate, rotund; flowers small, blue, about 6 lines long, including the spur; sepals oblong-ovate; petals a little exceeding the stamens; spurs hooked at the tip; styles shorter, included. *Porter and Coulter's Flora of Colorado.*

ACTÆA, L. BANEBERRY.

A. spicata, L., var. **rubra,** Ait. Red Baneberry.

Common through the wooded portions of the state.

A. alba, Bigelow. White Baneberry.

Common, with same extent as the last. Berries frequently borne on slender, green pedicels.

NIGELLA, L. FENNEL-FLOWER.

N. Damascena, L.* *Fennel-flower.*

Escaped from cultivation, Mankato, *Leiberg.*

MENISPERMACEÆ. MOONSEED FAMILY.

MENISPERMUM, L. MOONSEED.

M. Canadense, L. Canadian Moonseed.

Frequent, often common, southward; extending north to Todd county and the northwest side of Mille Lacs, *Upham;* also in the Red river valley near Saint Vincent, *Dawson, Havard.* (Its long, slender, bitter, yellow root is used by the Sioux as a medicine, being called *Pejuta zizi;* and from this came the name Pejuta zizi, or Yellow Medicine river. *T. M. Young.*)

BERBERIDACEÆ. BARBERRY FAMILY.

BERBERIS, L. BARBERRY.

B. vulgaris, L. *Common Barberry.*

Spontaneous in old fields, Mankato, *Leiberg.*

CAULOPHYLLUM, Michx. BLUE COHOSH.

C. thalictroides, Michx. Blue Cohosh. Pappoose-root.

Common, or frequent, excepting northeastward.

PODOPHYLLUM, L. MAY-APPLE. MANDRAKE.

P. peltatum, L. May-Apple, Mandrake.

Common southeastward, extending north to Goodhue and Rice counties.

NYMPHÆACEÆ. WATER-LILY FAMILY.

BRASENIA, Schreber. WATER-SHIELD.

B. peltata, Pursh. Water-Shield.

Rainy lake and lake of the Woods, *Macoun*; Pleasant lake, near Saint Cloud,

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**Nigella Damascena*, L. Flowers bluish, rather large, surrounded and overtopped by a finely divided leafy involucre, like the other leaves; succeeded by a smooth inflated 5-celled pod, in which the lining of the cells separates from the outer part. *Gray's Field, Forest, and Garden Botany.*

Campbell; Benton county, *Upham;* shallow lakes near St. Croix river, *Parry;* White Bear lake, Ramsey county, *Simmons;* Minneapolis, *Herrick;* Excelsior, *Mrs. Terry;* Fergus Falls, *Leonard.* Infrequent.

NELUMBIUM, Juss. NELUMBO. SACRED BEAN.

N. luteum, Willd. Yellow Nelumbo. Water Chinquapin. "Rattle-box."

Upper Mississippi river, *Houghton;* lake Minnetonka (north end of Halsted's bay), *Roberts;* Mendota, *Mrs. Terry;* Mississippi river at Red Wing. *Sandberg,* near Dresbach, Winona county, *Winchell,* and at La Crosse, *Swezey.* Rare.

NYMPHÆA, Tourn. WATER-NYMPH. WATER-LILY.

N. odorata, Ait. Sweet-scented Water-Lily.

Plentiful in lakes along the international boundary northwest of lake Superior. *Winchell.* Abundant throughout Quebec and Ontario and extending westward to the lake of the Woods, *Macoun.* This species probably occurs also in central and southern Minnesota, in company with the following. *Mr. Leiberg* reports the examination of a great number of Nymphæa rootstalks, none of them bearing tubers, at Lake Crystal; Blue Earth county.

N. odorata, Ait., var. **minor,** Sims. Smaller Sweet-scented Water-Lily.

Turtle lake, Otter Tail county (flowers only one and a half inches broad), *H. B. Ayres.* Rare.

N. tuberosa, Paine. Tuber-bearing White Water-Lily.

The white lilies common or frequent in ponds or lakes throughout the state, excepting near its west side, which have been called Nymphæa odorata, are believed to belong instead, for the most part, to this species. "Flowers large and delicately beautiful, fragrant." (*Wheeler and Smith.*) "This is really the water-lily of the Great lakes, as the true N. odorata seems to be confined to the northern waters, both lakes and rivers." (*Macoun.*)

NUPHAR, Smith. YELLOW POND-LILY. SPATTER-DOCK.

N. advena, Ait. Common Yellow Pond-Lily.

Common throughout the state.

N. luteum, Smith. Smaller Yellow Pond-Lily.

In small lakes east of the lake of the Woods, *Macoun.*

N. pumilum, Smith. (N. luteum, Smith, var. pumilum, Gray.) Small Yellow Pond-Lily.

Plentiful in Duluth harbor, *Roberts;* north shore of lake Superior, *Agassiz;* east shore of Rainy lake (rather rare), *Macoun;* Morrison county. *Miss Babbitt.*

SARRACENIACEÆ. PITCHER-PLANT FAMILY.

SARRACENIA, Tourn. SIDE-SADDLE FLOWER.

S. purpurea, L. Pitcher-Plant. Huntsman's Cup.

Common northward, extending south to Minneapolis, *Roberts, Winchell;* rare farther southeast.

PAPAVERACEÆ. Poppy Family.

PAPAVER, L. Poppy.

P. somniferum, L. *Common Poppy. Opium Poppy.*
Adventive in old gardens, Mankato, *Leiberg.*

SANGUINARIA, Dill. Blood-root.

S. Canadensis, L. Blood-root.
Common, or abundant, throughout most of the state; less frequent westward, as at Fergus Falls, *Leonard*, and Pembina, *Havard;* rare north of lake Superior, *Clark.*

FUMARIACEÆ. Fumitory Family.

DICENTRA, Bork. Dicentra.

D. Cucullaria, DC. Dutchman's Breeches.
Common southward; extending north at least to Stillwater, Anoka and Stearns counties, and Fergus Falls.

D. Canadensis, DC. Squirrel Corn.
Saint Paul, *Miss Cathcart;* Minneapolis, *Twining;* Faribault, *Miss Beane;* Blue Earth county, *Leiberg.*

CORYDALIS, Vent. Corydalis.

C. glauca, Pursh. Pale Corydalis.
Common north of lake Superior, *Roberts;* extending south to Stearns and Benton counties, *Upham*, and to the falls of the St. Croix river, *Parry, Miss Field.*

C. flavula, DC. Yellow Corydalis.
Thomson, Duluth and Taylor's Falls, *Miss Cathcart;* upper Mississippi river, *Garrison;* Red river valley, *Gedge;* Blue Earth county, *Upham.*

C. aurea, Willd. Golden Corydalis.
Common, or frequent, through the north half of the state; less frequent southward.

C. aurea, Willd., var. **micrantha**, Engelm.
Martin county, Minnesota, and Emmet county, Iowa (rare), *Cratty.*

FUMARIA, L. Fumitory.

F. officinalis, L. *Common Fumitory.*
Adventive, Winona, *Holzinger.*

CRUCIFERÆ. Mustard Family.

NASTURTIUM, R. Br. Water-Cress.

N. officinale, R. Br. *True Water-Cress.*
Stearns county, *Mrs. Blaisdell;* New Ulm, *Juni;* cold springs, Kasota, *Leiberg;* Tuttle's creek, Minneapolis, *Kassube;* lake Pepin, *Miss Manning.* Infrequent.

N. sinuatum, Nutt. Water-Cress.

Upper Mississippi river, *Garrison;* New Ulm, *Juni;* Pipestone county, *Leiberg;* lower Minnesota river, *Parry;* lake Pepin, *Miss Manning.*

N. sessiliflorum, Nutt. Water-Cress.

Lapham. Winona county, *Holzinger.* South.

N. palustre, DC. Marsh Cress.

Common, or frequent, throughout the state.

N. palustre, DC., var. **hispidum**, Fisch. & Mey.

Redwood Falls, *Pemberton.* Perhaps the prevailing form of the species in this state.

N. lacustre, Gray. Lake Cress.

Lapham. Southeast.

N. Armoracia, Fries. *Horse-radish.*

Adventive, Mankato, *Leiberg;* Northfield, *Chaney.*

DENTARIA, L. TOOTHWORT. PEPPER-ROOT.

D. diphylla, Michx. Two-leaved Pepper-root.

Freeborn and Blue Earth counties, *Upham;* lake Superior, *Whitney.* East.

D. laciniata, Muhl. Toothwort.

Frequent southeastward; extending northwest to Saint Paul, *Miss Cathcart,* Martin county, *Cratty,* and Fergus Falls, *Leonard.*

CARDAMINE, L. BITTER CRESS.

C. rhomboidea, DC. Spring Cress.

Frequent, or common, throughout the state.

C. pratensis, L. Cuckoo Flower.

Lake Superior to the sources of the Mississippi, *Houghton.* North.

C. hirsuta, L. Small Bitter Cress.

Common through the north half of the state; less frequent or rare southward. Glabrous specimens are sent by *Mr. Cratty* from Emmet county, Iowa. "A peculiar form grows on the height of land west of lake Superior, which seems to connect the species with the following variety," *Macoun.*

C. hirsuta, L., var. **sylvatica**, Gray.

Lake Minnetonka, *Roberts, Herrick;* Martin county (in woods), *Cratty,* determined by *Watson.*

ARABIS, L. ROCK CRESS.

A. lyrata, L. Rock Cress.

Common, or frequent, through the north half of the state; extending thus south to Red Wing (common), *Sandberg,* and Winona, *Holzinger;* wanting southwestward.

A. dentata, Torr. & Gray. Rock Cress.

Woods. Blue Earth county, *Leiberg;* Martin county (plentiful), *Cratty.* South.

A. hirsuta, Scop. Hairy Rock Cress.

Frequent throughout the state.

A. lævigata, Poir. Smooth Rock Cress.

Lake Pepin, *Miss Manning;* Goodhue county, *Sandberg;* Minneapolis, *Twining, Roberts;* Isanti and Sherburne counties, *Upham;* Stearns county, *Garrison;* lake Superior, *Whitney.*

A. Canadensis, L. Sickle-pod.

Frequent through the south half of the state; extending north to the upper Mississippi river, *Garrison.*

A. perfoliata, Lam. Tower Mustard.

Poplar river, lake Superior, *Juni;* upper Mississippi river, *Garrison*; Stearns county, *Campbell;* Blue Earth county, *Leiberg*; lake Pepin, *Miss Manning.*

A. Drummondii, Gray. Drummond's Tower Mustard.

Frequent, often common, throughout the state.

THELYPODIUM, Endl. ROCK CRESS.

T. pinnatifidum, Watson. (Arabis hesperidoides, Gray). Rock Cress.

Northfield, *Chaney.* South.

BARBAREA, R. Br. WINTER CRESS.

B. vulgaris, R. Br., var. **stricta**, Regel. Winter Cress. Yellow Rocket.

Put in bay, lake Superior, *Juni;* upper Mississippi river, *Garrison;* Minneapolis, *Roberts.*

ERYSIMUM, L. TREACLE MUSTARD.

E. cheiranthoides, L. Worm-seed Mustard.

Frequent, or common, throughout the state.

E. asperum, DC.* Prairie Rocket. Western Wall-flower.

Abundant at Walhalla, Dakota, thirty miles west of the Red river, *Scott;* "a very prominent object on dry, gravelly soil throughout the prairie region" of Manitoba, *Macoun*, and ranging thence south to Mexico; doubtless extending sparingly into the west edge of Minnesota; also found by *Rev. J. Pemberton* at Redwood Falls, and by *Dr. Sandberg* on the limestone bluff of Belle creek opposite to the mill in Vasa, Goodhue county, occurring (like Vesicaria Ludoviciana in the same county) far east from its general limit.

E. parviflorum, Nutt.† Small-flowered Prairie Rocket.

Red river valley, *Dawson, Scott;* Minneapolis (beside railroad a mile southeast from the university: determined by *Mr. Watson* as this species; having light yellow "petals but half longer than the (3 to 4 lines long) sepals"; yet much branched near the base, numerous stems of nearly equal hight (1 to 1½ feet) being thus sent up from a single root; leaves narrowly lanceolate, mostly entire; pods about 1½ inches long, beaked with a stout style, erect on short pedicels), *Upham.* West.

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*ERYSIMUM ASPERUM, DC. Biennial, canescent with short appressed hairs: stems solitary and simple, rarely branched above, 1 to 3 feet high, or less: leaves oblanceolate or narrowly spatulate; the cauline linear to linear-lanceolate, entire or sparingly repand with short acute teeth, 1 to 3 inches long: sepals narrow, 4 to 6 lines long, strongly gibbous: petals 8 to 12 lines long, light yellow to deep orange or purple: pods 1 to 4 inches long, a line wide, beaked with a stout style, ascending on stout spreading pedicels 3 lines long. *Brewer and Watson's Botany of California.*

†See description of ERYSIMUM PARVIFLORUM, Nutt., on next page.

SISYMBRIUM, L. HEDGE MUSTARD.

S. officinale, Scop. *Hedge Mustard.*
A common or frequent weed through the south half of the state.

S. Thaliana, Gay. *Mouse-ear Cress.*
Minneapolis, *Winchell*, *Miss Butler*. Rare.

S. canescens, Nutt. Tansy Mustard.
Frequent, or common, throughout the state.

S. canescens, Nutt., var. **brachycarpum**, Torr. & Gray.*
Red river valley, *Dawson*. North.

BRASSICA, Tourn. MUSTARD.

B. Sinapistrum, Boiss. *Charlock. Field Mustard.*

A common or frequent weed in grain-fields throughout the state; so troublesome in the Red river valley and southwestward that farmers allowing it to go to seed are subjected to a penalty by law.

B. alba, Gray. *White Mustard.*

Lake City, *Miss Manning*; Goodhue county, *Sandberg*; Blue Earth county, *Leiberg*; Stearns county, *Garrison*. Rare.

B. nigra, Koch. *Black Mustard.*
A common or frequent weed through the south half of the state.

B. campestris, L.† *Kale.*

Common in fields in Manitoba and around Winnipeg, *Macoun*; doubtless also in the Red river valley in this state.

DRABA, L. WHITLOW-GRASS.

D. arabisans, Michx. Whitlow-Grass.
North shore of lake Superior, *Juni*. Infrequent. North.

D. nemorosa, L., var. **hebecarpa**, Lindb. (D. nemoralis, Ehrh.)
About Rainy lake, *Drummond (Macoun)*. North.

ERYSIMUM PARVIFLORUM, Nutt. (E. lanceolatum, Hook.) Canescently scabrous with an appressed 2-parted pubescence; stem low (about a foot high) and nearly simple; leaves remarkably narrow, all linear or somewhat lanceolate, almost wholly entire, densely clustered at the base of the stem; siliques long, erect; stigma emarginate; flowers small, sulphur yellow; claws of the petals longer than the calyx. Distinguished from E. cheiranthoides by its more pubescent leaves, [longer] siliques and larger flowers. *Torrey and Gray's Flora of N. A.*

*SISYMBRIUM CANESCENS, Nutt., var. BRACHYCARPUM, Torr. & Gray. Lobes of the leaves somewhat acute, and, with the stem, furnished with minute stipitate glands; petals rather longer than the calyx; siliques scarcely attenuate at the base, somewhat longer than the pedicels. *Torrey and Gray's Flora of N. A.*

†*Brassica campestris*, L. Annual weed in cultivated fields and waste places; stem 1¼ to 3 feet high, with a few scattered, reversed hairs below; leaves somewhat fleshy and glaucous, lower lyrate-dentate, subciliate, 3 to 7 inches long, one-third as wide, the upper ones smaller, entire with rounded clasping lobes at base, tapering to an obtuse point; raceme 1 to 2 feet long; sepals erect, spreading; corolla yellow, 4 to 5 lines in diameter; siliques 1¼ inches long, with the style ¼ inch; seeds small, dark brown. *Wood's Class-Book.*

D. nemorosa, L., var. **leiocarpa**, Lindb.* (D. lutea, Gilib. [DC.])
Stearns county, *Campbell;* near Glyndon, *Gedge;* Pipestone county, *Mrs. Bennett.* Rare. North and west.

D. Caroliniana, Walt. Whitlow-Grass.
Frequent southward, extending north to Stearns county, *Mrs. Blaisdell*, and west to Pipestone county, *Mrs. Bennett.*

D. Caroliniana, Walt., var. **micrantha**, Gray.
Common in Iowa, *Arthur*; doubtless occurring also in Minnesota.

D. verna, L. Whitlow-Grass.
Saint Paul, *Miss Cathcart.* Rare. South.

ALYSSUM, Tourn. ALYSSUM.

A. calycinum, L. *Alyssum.*
Minneapolis, *Juni, Roberts;* Lake City, *Miss Manning;* Nicollet county, *Aiton.* Infrequent.

VESICARIA, Tourn. BLADDER-POD.

V. Ludoviciana, DC.† Bladder-pod.
Red river valley, *Scott*, determined by *Watson*; also, Mississippi river bluffs, Red Wing, *Sandberg.* West.

CAMELINA, Crantz. FALSE FLAX.

C. sativa, Crantz. *False Flax.*
Minneapolis, *Juni;* along railways, Blue Earth county (introduced in flax-seed), *Leiberg;* Emmet county, Iowa (rare), *Cratty;* Pipestone county, *Mrs. Bennett;* Red river valley, *Dawson.* Infrequent.

SUBULARIA, L. AWLWORT.

S. aquatica, L. Awlwort.
Found in about three feet of water, on sandy bottom in Vermilion bay, on Eagle lake, Canadian Pacific railway, Manitoba, near Rainy lake; abundant both in flower and fruit, Sept 13, 1882, *Fletcher, Macoun.* This rare species probably also occurs, and should be looked for, in northern Minnesota.

CAPSELLA, Vent SHEPHERD'S PURSE.

C. Bursa-pastoris, Mœnch. *Shepherd's Purse.*
A very abundant weed throughout the state.

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*DRABA NEMOROSA, L., var. LEIOCARPA, Lindb. Pubescent; stem branching, leafy, 6 to 15 inches high, very slender, sometimes branching from the base; pubescence simple or forked; leaves oval, cauline ones lanceolate, toothed; flowers very small, yellow; petals about twice as long as the calyx; style none; silicles oblong-elliptical, rather obtuse, glabrous, about 4 lines long, one-third to one-half the length of the slender spreading pedicels. *Porter and Coulter's Flora of Colorado.*

†VESICARIA LUDOVICIANA, DC. Canescent with a stellate pubescence; stem 6 to 8 inches high, simple, or somewhat branched above; radical leaves spatulate, entire, obtuse, cauline linear: flowers golden yellow; petals obovate; style slender, longer than the ovary and nearly as long as the obovate, globose, hairy silicle. *Porter and Coulter's Flora of Colorado.*

THLASPI, Tourn. PENNYCRESS.

T. arvense, L. *Field Pennycress. Mithridate Mustard.*

Lapham. Pembina, *Havard*. "Abundant on the Red river near the older settlements" [in Manitoba]; "not yet common as far south as the forty-ninth parallel, but rapidly spreading. A most noxious weed." *Dawson*.

LEPIDIUM, L. PEPPERWORT. PEPPERGRASS.

L. Virginicum, L. Wild Peppergrass.

Common, or frequent, throughout the state, excepting perhaps northward.

L. intermedium, Gray. Wild Peppergrass.

Abundant (petals usually wanting) throughout the state. Both species are native weeds.

CAKILE, Tourn. SEA-ROCKET.

C. Americana, Nutt. American Sea-Rocket.

"Abundant on the sandy south shore" of lake Superior, *Whitney*; at Thunder bay, *Macoun*; doubtless also on the shore of lake Superior in Minnesota.

CAPPARIDACEÆ. CAPER FAMILY.

POLANISIA, Raf. POLANISIA.

P. graveolens, Raf. Heavy-scented Polanisia.

Common through the south half of the state, extending north at least to Douglas county, *Mrs. Terry*; probably also in the Red river valley. (Two varieties are common at Minneapolis, one bearing yellowish, and the other pinkish flowers. *Herrick*.)

CLEOME, L. CLEOME. SPIDER FLOWER.

C. integrifolia, Torr. & Gray.* Cleome. Spider Flower.

Mankato, *Upham, Leiberg*. An immigrant from the plains west of Minnesota. Southwest.

VIOLACEÆ. VIOLET FAMILY.

VIOLA, L. VIOLET.

V. rotundifolia, Michx. Round-leaved Violet.

North of lake Superior (common), *Roberts*; upper Mississippi river, *Garrison*; extending south to Minneapolis, *Griswold*, and Saint Paul, *Miss Cathcart*.

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*CLEOME, L. Sepals distinct or somewhat united. Stamens 6 or rarely 4. Torus minute. Pod linear or oblong, subsessile or stipitate. Annual herbs, or shrubs, with digitate or simple leaves and racemed or solitary flowers. *Benth. & Hook.*

CLEOME INTEGRIFOLIA, Torr. & Gray. Annual, somewhat glaucous, 2 to 3 feet high, widely branching; leaves 3-foliolate; leaflets lanceolate (the lowermost oblong), entire, submucronate; racemes sometimes nearly 1 foot long; flowers large, showy, reddish purple, rarely white; sepals united to the middle, persistent; segments triangular-acuminate; petals with very short claws; stamens equal; pods oblong-linear, compressed, much longer than the stipe. *Porter and Coulter's Flora of Colorado.*

V. lanceolata, L. Lance-leaved Violet.

Near Saint Paul, *Mrs. Terry*. Rare. South.

V. primulæfolia, L. Primrose-leaved Violet.

Near Saint Paul, *Mrs. Terry;* Pipestone county, *Mrs. Bennett*. Rare. South.

V. blanda, Willd. Sweet White Violet.

Frequent throughout the state.

V. renifolia, Gray.* Kidney-leaved Violet.

Abundant in cedar swamps and mossy woods from northern New England through Canada and Manitoba to British Columbia, *Macoun;* doubtless in northern Minnesota.

V. Selkirkii, Pursh. Selkirk's Violet. Great-spurred Violet.

Upper Mississippi river, *Garrison*. Rare. North.

V. cucullata, Ait. Common Blue Violet.

Common, often abundant, throughout the state.

V. cucullata, Ait., var. **palmata,** Gray. Hand-leaf Violet.

Lake Pepin, *Miss Manning*; Minneapolis, *Herrick, Griswold;* Worthington (common), *Foote*.

V. cucullata, Ait., var. **cordata,** Gray.

Near Minneapolis, *Mrs. Terry;* Nicollet county, *Aiton*.

V. sagittata, Ait. Arrow-leaved Violet.

Frequent southeastward; extending north to Minneapolis, *Roberts*, Marine Mills, Washington county, *Miss Field*, and Anoka county, *Juni;* and northwest to Fergus Falls, *Leonard*.

V. delphinifolia, Nutt. Larkspur Violet.

Frequent, often common, through the south half of the state; extending north to Morrison county, *Upham*, and along the Red river valley.

V. pedata, L. Bird-foot Violet.

Abundant, or common, through the south half of the state and in the Red river valley.

V. canina, L., var. **sylvestris,** Regel. Dog Violet.

Frequent, but not common, throughout most of the state; rare southward.

V. striata, Ait. Pale Violet.

Hennepin county, *Herrick;* Alexandria, *Mrs. Terry*. Infrequent.

V. Canadensis, L. Canada Violet.

Frequent northward, and found more rarely throughout the south half of the state; extending southwest to Martin county (very scarce), *Cratty*, and Pipestone county, *Mrs. Bennett*. Flowers light pink.

V. pubescens, Ait. Downy Yellow Violet.

Common, or frequent, throughout the state.

V. pubescens, Ait., var. **eriocarpa,** Nutt.

Frequent in the vicinity of Hesper, Iowa, at the southern boundary of Minnesota, adjacent to Houston and Fillmore counties, *Mrs. Carter*.

V. tricolor, L. *Pansy. Heart's Ease.*

Rarely adventive, Stearns county, *Garrison*.

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*VIOLA RENIFOLIA, Gray. Rootstock and flowers as in V. blanda, or somewhat larger; leaves reniform (when fully grown usually two inches wide), on both sides, as also the petiole, villous-pubescent; scape pubescent. *Gray* in *Proc. Am. Acad. of Arts and Sciences*, 1870.

CISTACEÆ. ROCK-ROSE FAMILY.

HELIANTHEMUM, Tourn. ROCK-ROSE.

H. Canadense, Michx. Frost-weed.

Common, or frequent, throughout the state, excepting near its west side and far northward; extending north to the upper Mississippi river, *Garrison*, and Fort Francis, Rainy river, *Macoun*.

HUDSONIA, L. HUDSONIA.

H. tomentosa, Nutt. Downy Hudsonia.

Fifteen-mile point, Rainy lake, and Hungry Hall, entrance to the lake of the Woods, *Macoun;* Minnesota point, near Duluth, and on sand dunes in Anoka county, *Roberts*; on sand hills in section 21, Orrock, Sherburne county (plentiful, with short-peduncled flowers and narrow leaves), *Upham;* near Rockford, Wright county, *Hatch;* barren ridges of the St. Croix, *Parry;* Castle Rock, Dakota county, *Geyer;* White Rock, Goodhue county, *Sandberg;* lake Pepin, *Miss Manning*. Local.

LECHEA, L. PINWEED.

L. minor, Walt. Small Pinweed.

Sturgeon lake (near the international boundary east of Rainy lake), *Macoun;* upper Mississippi, *Houghton;* St. Croix river, *Parry;* Steele county, *Upham.*

DROSERACEÆ. SUNDEW FAMILY.

DROSERA, L. SUNDEW.

D. rotundifolia, L. Round-leaved Sundew.

Common, or frequent, northward; extending south to Minneapolis, *Roberts*.

D. intermedia, Drev. and Hayne, var. **Americana,** DC. (D. longifolia, in *Manual.*) Long-leaved Sundew.

Similar in range with the last, but less frequent. North shore of lake Superior at Little Marais, *Juni;* between the lake of the Woods and Red river (common), *Dawson;* extending south to sections 17 and 19, Ham Lake, Anoka county (with the leaves scattered along the stem or caudex), *Roberts.*

D. linearis, Goldie. Slender Sundew.

Lake Superior to Roseau river, *Burgess, Macoun;* extending south to Hennepin county (frequent), *Roberts.*

HYPERICACEÆ. ST. JOHN'S-WORT FAMILY.

HYPERICUM, L. ST. JOHN'S-WORT.

H. pyramidatum, Ait. Great St. John's-wort.

Rare or local northward, but frequent southward; extending north to Todd county, *Upham*, the upper Mississippi and Minnesota rivers, *Parry*, and northwest to the plains of the Saskatchewan, *Bourgeau, Macoun.*

[H. Kalmianum, L., probably occurs on the north shore of lake Superior in this state.]

H. prolificum, L. Shrubby St. John's-wort.
Vasa, Goodhue county, *Sandberg.* Southeast.

H. ellipticum, Hook. St. John's-wort.
Lapham. Upper Mississippi river, *Garrison.* [Devil's lake, Dakota, *Geyer.*] Infrequent. North.

[*H. perforatum*, L., may be expected as a weed southeastward.]

H. corymbosum, Muhl. St. John's-wort.
Lapham. Lake Pepin, *Miss Manning;* Hesper, Iowa, adjacent to the south line of Houston and Fillmore counties, *Mrs. Carter.* Rare.

H. mutilum, L. Slender St. John's-wort.
Throughout the state; common northward, less frequent southward.

H. mutilum, L., var. **gymnanthum,** Gray.
Minneapolis, *Roberts.*

H. Canadense, L. Canadian St. John's-wort.
St. Croix river, *Parry;* Stearns county, *Campbell;* Sibley county, *Leonard;* Martin county (rare), *Cratty.*

H. Canadense, L., var. **major,** Gray.
Lake Superior, *Robbins,* and in Iowa, *Arthur;* doubtless also in Minnesota.

ELODES, Adans. MARSH ST. JOHN'S-WORT.

E. Virginica, Nutt. Marsh St. John's-wort.
Throughout the state; common northward, frequent southward.

CARYOPHYLLACEÆ. PINK FAMILY.

SAPONARIA, L. SOAPWORT.

S. officinalis, L. *Common Soapwort. Bouncing Bet.*
Blue Earth county, *Leiberg;* Lake City, *Miss Manning;* Wabasha, *Gibson.*

S. Vaccaria, L. (*Vaccaria vulgaris,* Host.) *Cow-Herb.*
Seldom plentiful, but reported at many places throughout the state. *Mr. Leiberg* writes: "This is becoming a common weed in the grain-fields of Blue Earth county, where the farmers call it 'cockle', and complain very much of it. It will doubtless become as plentiful as the true cockle (*Lychnis Githago*). Most of the seeds are just small enough to pass through a wheat-screen, and they can thus be separated; but, as the largest seeds will be left in whenever the grain is cleaned, the result will be that in time, through this process of selection, the seeds can no more be cleaned out of the wheat than true cockle."

SILENE, L. CATCHFLY. CAMPION.

S. stellata, Ait. Starry Campion.
Common through the south part of the state; extending north at least to Minneapolis, *Herrick,* and Redwood Falls, *Miss Butler.*

S. nivea, DC. Campion.
Upper Mississippi river, *Garrison;* Goodhue county, *Sandberg;* Hesper, Iowa, adjoining Houston county, *Mrs. Carter.* Rare. Southeast.

S. Virginica, L. Fire Pink. Catchfly.
Nicollet county, *Leiberg.* Rare. Southeast.

S. antirrhina, L. Sleepy Catchfly.
Frequent, or common, throughout the state.

S. noctiflora, L. *Night-flowering Catchfly.*
Frequent throughout the state.

LYCHNIS, Tourn. LYCHNIS. COCKLE.

L. vespertina, Sibth. *Evening Lychnis.*
Minneapolis, *Juni, Kassube, Moulton.* Rare.

L. Githago, Lam. *Corn Cockle.*
A common weed in wheat-fields throughout the state.

ARENARIA, L. SANDWORT.

A. serpyllifolia, L. *Thyme-leaved Sandwort.*
Northfield, *Chaney.* Rare.

A. Michauxii, Hook. (A. stricta, Michx.) Strict Sandwort.
Rooting on detached rocks, head of lake St. Croix, *Parry;* lake of the Woods, *Macoun.* Rare.

A. lateriflora, L. Showy Sandwort.
Frequent throughout the state.

STELLARIA, L. CHICKWEED. STARWORT.

S. media, Smith. *Common Chickweed.*
Frequent throughout the state.

S. longifolia, Muhl. Long-leaved Stitchwort.
Common throughout the state.

S. longipes, Goldie. Long-stalked Stitchwort.
Minneapolis, *Griswold, Kassube;* Anoka county and Duluth, *Juni.* [Devil's lake, Dakota, *Geyer.*] North.

S. crassifolia, Ehrh. Starwort.
Cannon Falls, Goodhue county, *Blake, Sandberg;* Minneapolis (plentiful in ditches in swamps), *Roberts, Upham;* and northward.

S. borealis, Bigelow. Northern Stitchwort. Starwort.
Common, or frequent, in the north half of the state. [The var. alpestris, Gray, has been found on the north side of lake Superior, at Pie island, by *Macoun.*]

CERASTIUM, L. MOUSE-EAR CHICKWEED.

C. viscosum, L. (*C. vulgatum,* L., in *Manual.*) *Mouse-ear Chickweed.*
Winona county, *Holzinger*; lake Pepin, *Miss Manning.* [Lake Superior, *Whitney.*] Infrequent.

C. vulgatum, L. (*C. viscosum,* L., in *Manual.*) *Large Mouse-ear Chickweed.*
Common, or frequent, throughout the state, excepting perhaps westward.

C. nutans, Raf. Nodding Mouse-ear Chickweed.
Frequent, or common, throughout the state, excepting southwestward.

C. oblongifolium, Torr. Mouse-ear Chickweed.
Winona county, *Holzinger;* Fergus Falls, *Leonard.* Rare. Southeast.

C. arvense, L. Field Chickweed.

Frequent, or common, through the north half of the state and southwestward ; rare southeastward.

SAGINA, L. PEARLWORT.

S. nodosa, E. Meyer. Pearlwort.

North shore of lake Superior, doubtless in Minnesota ; Isle Royale, *Whitney;* island of St. Ignace, *Macoun.*

PARONYCHIEÆ. WHITLOW-WORT FAMILY.

ANYCHIA, Michx. WHITLOW-WORT. NAILWORT.

A. dichotoma, Michx. Forked Chickweed. Whitlow-wort.

Lapham. Infrequent.

FICOIDEÆ. ICE PLANT FAMILY.

MOLLUGO, L. INDIAN-CHICKWEED.

M. verticillata, L. Carpet-weed.

Common, or frequent, southward. Exposed rocks and sandy fields, St. Croix river, *Parry;* abundant in Hennepin county on sandy river-banks, appearing indigenous, *Roberts.*

PORTULACACEÆ. PURSLANE FAMILY.

PORTULACA, Tourn. PURSLANE.

P. oleracea. L. *Common Purslane.* "*Pusley.*"

A very common garden weed.

P. retusa, Engelm.* Western Purslane.

Upper Minnesota river, *Parry*; Yellow Medicine county, *Upham*; upper Mississippi river, *Garrison.* (Surely indigenous ; yet possibly to be referred to the foregoing species.) West.

TALINUM, Adans. TALINUM.

T. teretifolium, Pursh. Talinum.

Rare, occurring only on ledges of rock (trap, syenite, granite and quartzite); absent far northward. Taylor's Falls (of St. Croix river), *Houghton, Miss Field*; Duluth, *Miss Cathcart*; Watab, Benton county, and at numerous places in Stearns and Morrison counties, *Upham*; upper Minnesota river, *Parry*; Redwood Falls, *Miss Butler*; "plentiful on most of the ledges in Rock and Pipestone counties (a handsome little plant, extremely easy of cultivation)," *Leiberg.*

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*PORTULACA RETUSA, Engelm. Like *P. oleracea*, L., but greener, and the stem more ascending, sometimes covering a space several feet in diameter ; leaves usually smaller than the common species; sepals obtuse, broadly carinate-winged ; petals yellow ; stigmas 3 or 4 ; capsule 2½ to 3 lines long, broader in proportion ; seeds more strongly tuberculate than in *P. oleracea. Brewer and Watson's Botany of California.*

CLAYTONIA, L. SPRING-BEAUTY.

C. Virginica, L. Narrow-leaved Spring-Beauty.

Throughout the state, but rare in most portions; frequent, or common, southeastward.

C. Caroliniana, Michx. Wide-leaved Spring-Beauty.

Lake City, *Mrs. Ray*. Southeast.

MALVACEÆ. MALLOW FAMILY.

MALVA, L. MALLOW.

M. rotundifolia, L. *Common Mallow.*

Common southward, and as far north as Morrison and Todd counties, *Upham*; but not yet common westward.

M. sylvestris, L. *High Mallow.*

Fort Francis, Rainy river, *Macoun*; Minneapolis, *Herrick*; Goodhue county, *Sandberg*; lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg*.

M. crispa, L. *Curled Mallow.*

Adventive, Lake City, *Miss Manning*.

CALLIRRHOE, Nutt. CALLIRRHOE.

C. triangulata, Gray. Callirrhoe.

Lapham. South.

NAPÆA, Clayt. GLADE MALLOW.

N. dioica, L. Glade Mallow.

Lapham. Vasa, Goodhue county, *Sandberg*. Rare. Southeast.

MALVASTRUM, Gray. FALSE MALLOW.

M. coccineum, Gray. Prairie Mallow.

Minnesota, *Gray's Manual*. West. Its eastern limit scarcely reaches into this state.

ABUTILON, Tourn. INDIAN MALLOW.

A. Avicennæ, Gærtn. *Velvet-Leaf.*

Anoka, Hennepin, Ramsey, Wabasha and Blue Earth counties. Infrequent.

HIBISCUS, L. ROSE-MALLOW.

H. militaris, Cav. Halberd-leaved Rose-Mallow.

Banks of the Mississippi river between Saint Paul and Mendota (abundant), *Mrs. Terry*. South.

H. Trionum, L. *Bladder Ketmia.* *Flower of an Hour.*

Adventive, Minneapolis, *Kassube*, *Upham*; Goodhue county, *Sandberg*; Martin county, *Gedge*. [This "has become abundant in many parts" of Nebraska, *Aughey*.]

TILIACEÆ. LINDEN FAMILY.

TILIA, L. LINDEN. BASSWOOD.

T. Americana, L. Basswood. Bass. Linden. Lime Tree. Whitewood.

Very abundant in the Big Woods, and generally common throughout the state; not found near the Minnesota shore of lake Superior, but frequent north of this lake, on maple ridges 400 feet and more above it, attaining a hight of 70 feet and diameter of 20 inches, *Clark*; also, not found in Rock county, but very plentiful at Bear lakes in Murray county, *Upham*; extending north to Basswood lake on the international boundary, *Winchell*.

[The northern limit of this species is found just south of Thunder bay, from which it nearly follows the international boundary to the lake of the Woods. It extends farther north in Manitoba, nearly to lake Winnipeg, and northwest to Fort Ellice. *Dr. Robert Bell.*]

(The leaves of this and many other species of trees, in their first few years of growth from the seed, are often remarkably large. The following measurements were made in Todd county, September 16th: leaf of basswood, blade, 14½ inches long and 12 inches wide, borne on a petiole 3 inches long; of large-toothed aspen, blade, 10 by 7½, and petiole, 4 inches; of balsam poplar, blade, 11 by 7, and petiole, 2 inches; and of elm, blade, 9 by 6 inches, with petiole only a half inch long.)

"Basswood lumber is much used in cabinet work for boxes, shelves, etc., whenever a wood is desired which is soft and easily worked, and, at the same time, tough and not liable to split." It decays more quickly than most kinds of lumber, when exposed to the weather, unless it is thoroughly painted; but is sufficiently durable, if kept dry.

LINACEÆ. FLAX FAMILY.

LINUM, L. FLAX.

L. perenne, L.* Wild Flax. Prairie Flax.

At Pembina, and thence westward, *Chickering*; Stearns county, *Mrs. Blaisdell*. West.

L sulcatum, Riddell. Wild Flax.

Common from Minneapolis, *Roberts*, southward, and westward to the Red river valley, *Upham*; Pipestone quarry, *Mrs. Bennett*.

L. rigidum, Pursh.† Wild Flax.

From Winona county, *Winchell*, Minneapolis, *Twining*, and Anoka county, *Juni*, westward to Pipestone county, *Leiberg*, and the Red river valley (common in Clay county), *Upham*. South and west.

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*LINUM PERENNE, L. Perennial, glabrous; leaves scattered, linear, acute; flowers nearly opposite the leaves and terminal; peduncles becoming elongated and nodding in fruit; sepals oval with membranous margins, shorter than the globose capsule; petals free, blue, retuse, 3 to 4 times exceeding the calyx; styles 5; capsule 5-celled, with bearded dissepiments. Stems ½ to 3 feet high; flowers large. May to September. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

†LINUM RIGIDUM, Pursh. Dwarf; glaucous; styles united almost to the top. *Gray's Manual.*—Stems 5 to 15 inches high, angled, much branched; branches strict, ascending; leaves alternate, linear, pungently acute, rigid, with scabrous margins; flowers panicled or corymbose; pedicels thickened at the end, and forming an exterior cup-shaped calyculus; sepals ovate-lanceolate, cuspidate, strongly 3-nerved, glandular spinulose-scabrous on the margins, longer than the globose capsule; petals sulphur-yellow. *Porter and Coulter's Flora of Colorado.*

L. usitatissimum, L. *Common Flax.*

Sometimes adventive in fields : Minneapolis ; Blue Earth county ; Redwood Falls ; Luverne.

GERANIACEÆ. GERANIUM FAMILY.

GERANIUM, L. CRANESBILL.

G. maculatum, L. Wild Cranesbill.

Common, often abundant, through the south half of the state ; extending northwest to Clay county, *Gedge*, the upper Mississippi river, *Garrison*, and the mouth of Rainy river, *Macoun*.

G. Carolinianum, L. Carolina Cranesbill.

Common, or frequent, throughout the state; most plentiful northward.

G. Robertianum, L. Herb Robert.

Falls of the St. Croix, *Parry*; Fergus Falls, *Leonard*; extending west to the lake of the Woods, *Macoun*. North.

ERODIUM, L'Her. STORKSBILL. HERON'S-BILL.

E cicutarium, L'Her. Storksbill. Heron's-bill.

Minneapolis, *Juni, Kassube, Roberts*. Rare. An abundant weed in the Pacific states and in some districts eastward.

IMPATIENS, L. BALSAM. JEWEL-WEED. TOUCH-ME-NOT.

I. pallida, Nutt. Pale Touch-me-not.

Throughout the state ; in many portions infrequent or rare ; common at New Ulm, *Juni*, and in Blue Earth county, *Leiberg*; abundant in Martin county, *Cratty*, and on the south shore of Red lake, *Miss Babbitt*.

I. fulva, Nutt. Spotted Touch-me-not.

Common throughout the state. ("At Beaver Bay a spotless variety, with less reflected spur, was common and grew intermingled with the ordinary form, without showing any signs of intergradation." *Roberts*.)

OXALIS, L. WOOD-SORREL. OXALIS

O. Acetosella, L. Common Wood-Sorrel.

Common north of lake Superior, *Roberts*; lake of the Woods, *Macoun*; extending northwest to the Saskatchewan, *Richardson*. North.

O. violacea, L. Violet Wood-Sorrel.

Common through the south half of the state to Pipestone county, *Mrs. Bennett*; extending north to the upper Mississippi river, *Garrison*, and in the Red river valley at least to Clay county, *Gedge*. (*Herrick* reports, besides the type, a variety that bears white flowers, occurring quite frequently in the vicinity of Castle Rock, Dakota county ; and *Miss Babbitt* finds the same at Little Falls. Succulent flower-bearing scapes, not accompanied by leaves, are occasionally seen in September [*Upham*]. "The usual occurrence of a white, carrot-shaped root beneath the ordinary scaly bulb" of this species is noticed by *Roberts*, in the *American Naturalist* for August, 1879. See also *Am. Nat.*, vol. xvi, pp. 13-19.)

O. corniculata, L., var. **stricta**, Sav. (O. stricta, L.) Yellow Wood-Sorrel. Ladies' Sorrel.

Common throughout the state.

RUTACEÆ. RUE FAMILY.

XANTHOXYLUM, Colden. PRICKLY ASH.

X. Americanum, Mill. Northern Prickly Ash. Toothache-tree.

Very abundant southward; extending north to Pine, Aitkin, Cass and Polk counties.

PTELEA, L. SHRUBBY TREFOIL. HOP-TREE.

P. trifoliata, L. Shrubby Trefoil. Hop-tree. Wafer Ash.

Lapham. Southeast.

ANACARDIACEÆ. CASHEW FAMILY.

RHUS, L. SUMACH.

R. typhina, L. Staghorn Sumach.

Limited to the east side of the state and the region from the upper Mississippi river northeastward, as follows: in Houston and Fillmore counties, rare; in Winona county the most frequent species on the bluffs of the Mississippi ("at Winona samples were seen eight inches in diameter", *Winchell*), but rare farther west; common in Ramsey and Hennepin counties, extending west into the Big Woods, and to Martin county, *Cratty;* rare in Benton county; common in Pine county and westward to Mille Lacs, Little Falls and lake Alexander, Morrison county; at Fish-hook lake in southwestern Cass county, *Garrison*; and occasional northeastward, being reported by *Clark* at Sandy lake, Fond du Lac, Grand Portage and Pigeon river.

R. glabra, L. Smooth Sumach.

Common throughout the state, excepting north of lake Superior, where it is rare.

R. copallina, L. Dwarf Sumach.

Houston county, near La Crescent, also in Winona county, *Winchell*; lake Pepin, *Miss Manning*; Goodhue county, *Sandberg*; Saint Paul, *Miss Cathcart*; Blue Earth county, *Leiberg*; Worthington, *Foote*; Pipestone county, *Mrs. Bennett.* Rare. South.

R. venenata, DC. Poison Sumach. Poison Dogwood.

Observed, like the preceding, in Houston county, near La Crescent, and in Winona county, by *Prof. Winchell*; Hennepin county, *Simmons*; Anoka county, *Juni*; upper Mississippi river, *Garrison.* Rare.

R. Toxicodendron, L. Poison Ivy. Poison Oak.

Common, often abundant, throughout the state. (Erect or decumbent, 1 to 3 feet high; not climbing.]

R. Toxicodendron, L., var. **radicans,** Torr.* Climbing Poison Ivy.

This variety (or species) occurs sparingly in the southeast part of the state. *Mrs. Carter. Miss Manning.*

R. aromatica, Ait. Fragrant Sumach.

Maligne river (near the international boundary east of Rainy lake). *Macoun.* Rare.

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*RHUS TOXICODENDRON, L., var. RADICANS, Torr. (R. radicans, L.) Stems climbing by means of innumerable radicating tendrils; leaflets 3, ovate, dark green, smooth and shining, entire, the lowest rarely angular; flowers greenish, racemed in axillary panicles; berries dull white. A vigorous woody climber, ascending trees and other objects 10 to 40 or 50 feet. The stem becomes 1 to 2 inches [or more] in thickness, covered with a greenish, scaly bark, and throws out all along its length myriads of thread-like rootlets, which bind it firmly to its support. *Wood's Class-Book.*

VITACEÆ. VINE FAMILY.

VITIS, Tourn. GRAPE.

V. Labrusca, L. Northern Fox-Grape.

Occurs frequently, according to *Clark*, in the east part of the state, as far northward as southern Pine county, and rarely on the St. Louis river; lake Pepin, *Miss Manning*.

V. æstivalis, Michx. Summer Grape.

Lapham. St. Croix Falls, *Miss Field*; Anoka county, *Juni*; Big Stone lake, *Winchell*; Fergus Falls, *Leonard*. Infrequent. South.

V. cordifolia, Michx.* Winter or Frost Grape.

Frequent in the south half of the state; also in the Red river valley, near Emerson, Manitoba, *Dawson*.

V. riparia, Michx.† (V. cordifolia, Michx., var. riparia, Gray.) Winter or Frost Grape.

Common throughout the state, excepting north of lake Superior.

AMPELOPSIS, Michx. VIRGINIAN CREEPER.

A. quinquefolia, Michx. Virginian Creeper. Five-leaf Ivy. American Ivy. "Woodbine."

Common through the south half of the state and in the Red river valley; probably less frequent northeastward. "A very desirable climber, often cultivated"

RHAMNACEÆ. BUCKTHORN FAMILY.

RHAMNUS, Tourn. BUCKTHORN.

R. alnifolia, L'Her. Alder-leaved Buckthorn.

St. Croix river, *Parry*; Minneapolis, *Winchell*, *Kassube*; beach of lake Superior, *Juni*; lake of the Woods, *Dawson*. Rare southward; common far northward.

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*VITIS CORDIFOLIA. Michx. Tall (or more rarely low), climbing high, trunks not rarely 6 to 9 inches in diameter; leaves middle-sized or small (2¼ to 3 or 4 inches in diameter), heart-shaped, mostly entire or very slightly tri-lobed on the edges, with broad, shallow teeth, usually smooth and shining, more on the upper than on the lower side, the young ones sometimes, and very rarely the old ones, with short hair on the ribs below; berries small, in large, mostly loose bunches, black, without a bloom, maturing late in the fall, usually only with a single short and thick seed, marked by a prominent raphe.—— This grows more especially in fertile soil, and is common in river and creek bottoms. *Engelmann*, in *Sixth An. Rep., Insects of Missouri*; also in *Bulletin of the Torrey Botanical Club*.

†VITIS RIPARIA, Michx. Mostly a smaller plant than the last, but with larger (3 to 5 inches in diameter) and more or less incisely 3-lobed, glabrous, shining (or rarely when young, slightly hairy) leaves, the lobes long and pointed, the teeth also more pointed than in V. cordifolia; berries usually larger than in the last, mostly with a bloom, in smaller and often more compact bunches, commonly 1-to 2-seeded; seeds with a less prominent raphe.—— This species prefers thickets or rocky soil on river-banks; the northern form has fewer and larger berries in a bunch, and is easily distinguished from V. cordifolia. The fruit ripens earlier than the former and is pleasanter. *Engelmann*, in *Insects of Mo.*, and in *Bull. Torr. Cl.*

CEANOTHUS, L. New Jersey Tea. Red-root.

C. Americanus, L. New Jersey Tea. Red-root.

Common throughout the state, excepting far northward; especially abundant on sandy tracts in the region of the upper Mississippi river. Though only a small shrub, one to three feet high, its root is a mass of gnarled wood, sometimes six or eight inches in diameter, "a troublesome obstacle in first breaking the soil."

C. ovatus, Desf. (C. ovalis, Bigelow.) Red-root.

Sandy ridges of the St. Croix, "seeming to take the place of the preceding species and an indication of a more barren soil," *Parry*; New Ulm, *Juni*. [Kaministiquia river (very abundant), *Macoun*.] Local.

CELASTRACEÆ. Staff-tree Family.

CELASTRUS, L. Staff-tree. Shrubby Bitter-sweet.

C. scandens, L. Climbing Bitter-sweet. Wax-work.

Common through the south half of the state, extending north to the sources of the Mississippi, and to Polk county; less frequent north to Emerson, Manitoba, *Scott*.

EUONYMUS, Tourn. Spindle-tree.

E. atropurpureus, Jacq. Burning-Bush. Waahoo.

Frequent southward; extending north to Anoka county, *Juni*, Lake Elizabeth, Kandiyohi county, *Mrs. Terry*, and Clay county in the Red river valley, *Gedge*.

E. Americanus, L., var. **obovatus**, Torr. & Gray. Trailing Strawberry Bush.

Minneapolis, *Winchell*; lake Pepin, *Miss Manning*. Rare.

SAPINDACEÆ. Soapberry Family.

STAPHYLEA, L. Bladder-Nut.

S. trifolia, L. American Bladder-Nut.

Frequent southward; extending north to Minnehaha falls, *Roberts*, and New Ulm, *Juni*.

ACER, Tourn. Maple.

A. Pennsylvanicum, L. Striped Maple. Moose-wood.

Common northeastward, extending south to the upper Mississippi river and to southeastern Pine county; rare and local farther south to lake Pepin, *Miss Manning*.

A. spicatum, Lam. Mountain Maple.

Abundant north of lake Superior and along the international boundary; extending south to Mille Lacs, *Upham*; rare and local farther southward on the Mississippi bluffs at lake Pepin, *Miss Manning*, and in section 22, Richmond, Winona county, *Winchell*.

A. saccharinum, Wang. Sugar Maple. Rock Maple. Hard Maple.

Common, often abundant, throughout the state, excepting near its west side. Not found close to the shore of lake Superior, but common two or three miles from it, 400 feet or more above the lake, attaining a hight of 75 feet, *Clark*. The northern limit of this tree, according to *Bell*, extends from the lower part of the valley of the Kaministiquia river westward, a little to the north of the boundary line, to the lake of the Woods, where it turns south. The Chippewa Indians, who are yet the principal inhabitants of the wooded region north of the Northern Pacific railroad, make considerable maple sugar, their ordinary product in the region of lake Superior, according to *Clark*, being from 100 to 500 pounds for each lodge.

A. saccharinum, Wang., var. **nigrum**, Torr. & Gray. Black Sugar Maple.

Houston county, *Winchell;* upper Mississippi river, *Garrison*. *Mr. J. C. Arthur* reports this variety common at Waterville, Le Sueur county, and believes it to be the prevailing form of the species at least through the south part of the state.

A. dasycarpum, Ehrh. White or Silver Maple. River Maple. Soft Maple.

Common southward, extending north to the upper Mississippi and the White Earth reservation, *Garrison*. More frequently cultivated for shade than the next, each of these species being often called soft maple.

A. rubrum, L. Red Maple. Swamp Maple. Soft Maple.

Common through the east part of the state; extending west to Mud Portage on the Dawson route (north of lake Superior), *Macoun*, the White Earth reservation, *Garrison*, and Redwood Falls, *Pemberton;* abundant in Winona county, *Winchell*. This and the two preceding species, especially the sugar maple, are valuable for furniture and cabinet work, and are fine shade and ornamental trees, for which purpose they are extensively raised from the seed or transplanted from the woods.

NEGUNDO, Mœnch. ASH-LEAVED MAPLE. BOX-ELDER.

N. aceroides, Mœnch. Box-Elder.

Common through the south half of the state, extending thus north to Kanabec, Mille Lacs and Wadena counties; less frequent farther north to the St. Louis river near Fond du Lac, *Winchell*, Kaministiquia river, *Macoun*, and the upper Mississippi river, *Garrison*; also abundant throughout the Red river valley and northwestward, reaching east to the lake of the Woods, *Dawson*. "Destined to be the shade tree of all the prairie cities" of Manitoba (*Macoun*). Along the Minnesota river, it sometimes exceeds three feet in diameter (*Winchell*). Sugar and syrup are made from it at Big Stone lake.

POLYGALACEÆ. MILKWORT FAMILY.

POLYGALA, Tourn. MILKWORT. POLYGALA.

P. sanguinea, L. Purple Milkwort.

Frequent, or common, southward; extending north to the upper Mississippi river, *Garrison*, and Polk county, *Upham*.

P. cruciata, L. Milkwort.

Margins of swampy lakes, St. Croix river, *Parry*; Minneapolis (frequent), *Roberts*; Stearns county, *Mrs. Blaisdell*.

P. verticillata, L. Milkwort.

Frequent, or common, in the south and west portions of the state; extending north to Minneapolis, *Simmons*, New Ulm, *Juni*, and the Red river valley, *Upham*.

P. Senega, L. Seneca Snakeroot.

Common, or frequent, throughout the state. Several tons of this medicinal root are dug and sold yearly by the Chippewa Indians in the region of Mille Lacs, the Crow Wing river and the White Earth reservation, the price which they receive for it, when dried, being from 35 to 50 cents per pound.

P. polygama, Walt. Pink Polygala.

Sandy soil, St. Croix river, *Parry;* lake Pepin, *Miss Manning*; Saint Cloud, *Garrison*; Anoka county and Brainerd, *Upham*; lake of the Woods, *Dawson*.

P. paucifolia, Willd. Fringed Polygala.

Faribault, Rice county, *Miss Beane*. [Kaministiquia river, north of lake Superior, *Macoun*.] Rare.

LEGUMINOSÆ. PULSE FAMILY.

LUPINUS, Tourn. LUPINE.

L. perennis, L. Wild Lupine. Perennial Lupine.

Common on light, sandy land from lake Pepin to the sources of the Mississippi river; also, Fergus Falls, *Leonard*. Rarely found with white flowers.

TRIFOLIUM, L. CLOVER.

T. arvense, L. *Rabbit-foot* or *Stone Clover*.

Saint Cloud, Stearns county, *Campbell*. Rare.

T. pratense, L. *Red Clover*.

Frequently adventive throughout the state.

T. repens, L. White Clover. Shamrock.

Occurring like the last, already very abundant in many districts; also quite certainly indigenous through the north half of the state, *Clark*, *Upham*.

T. hybridum, L.* *Alsike Clover*.

Adventive, but scarcely established, Saint Cloud (sandy soil, on the grounds of the Normal School), *Campbell*. Rare.

T. procumbens, L. *Yellow Clover*. *Low Hop-Clover*.

Stearns county (both the type and the var. minus, Koch), *Campbell;* Saint Paul, Minneapolis and lake Minnetonka (sparingly adventive), *Roberts;* lake Pepin, *Miss Manning*. Rare.

MELILOTUS, Tourn. MELILOT. SWEET CLOVER. HART'S CLOVER.

M. officinalis, Willd. *Yellow Melilot*.

Goodhue county, *Sandberg;* Minneapolis (frequent), *Roberts;* Stearns county, *Garrison:* Blue Earth county, *Leiberg*. South.

M. alba, Lam. *White Melilot*.

Throughout the south half of the state. More frequent than the preceding.

MEDICAGO, L. MEDICK.

M. sativa, L. *Lucerne*. *Alfalfa*.

Escaped from cultivation, Blue Earth county, *Leiberg;* Minneapolis, *Winchell*.

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* *Trifolium hybridum*, L. Almost glabrous; leaflets obovate or oblong; stipules oblong, tips triangular; heads axillary, peduncled, globose; pedicels elongate, at length reflexed; flowers [whitish, rose-tinted] drooping; calyx-tube campanulate, gibbous; teeth subulate, nearly equal, unaltered in fruit. *Hooker's Students' Flora of the British Islands*. (See *Botanical Gazette*, vol. vii, pp. 121 and 135.)

HOSACKIA, Dougl. HOSACKIA.

H. Purshiana, Benth.* Hosackia.

Gravelly shore of Swan lake, section 7, Underwood, Redwood county (leaves about ½ inch long, very short-petioled, of three oblong acute leaflets, the lateral ones oblique in their lower half), *Upham*. Southwest.

PSORALEA, L. PSORALEA.

P. tenuiflora, Pursh. (P. floribunda, Nutt.) Psoralea.

Cottonwood county, *Holzinger*. Southwest

P. argophylla, Pursh. Silvery-leaved Psoralea.

Abundant in all the prairie portion of the state; extending northeast to the upper Mississippi river, *Garrison*. (See note in *American Naturalist*, vol. xvii, p. 414.)

P. esculenta, Pursh. Dakota Turnip. Pomme blanche. Pomme de Prairie. Pomme de Terre.

Common southwestward; extending east to the rising ground east of Red river prairie, *Dawson*, the Roseau river, *Scott*, Morrison county, *Upham*, Minneapolis (rare, found close east of lake Calhoun), *Griswold*, *Roberts*, and Blue Earth county, *Leiberg*. "*Pomme de Prairie* of the French voyageurs; *Tipsinah* of the Sioux Indians. It occurs over a wide range of country between the Mississippi and the Rocky Mountains, and is a characteristic plant of the Coteau des Prairies. The root, frequently attaining the size of a hen's egg, is of a regular, cylindric, ovoid shape, consisting of a thick, leathery envelope, easily separating when fresh from its smooth internal part. The latter is of a friable texture, except towards the axis, where some ligneous fibres are intermixed. When dry, it acquires a sweetish taste, and is easily pulverized, affording a light, starchy flour, suitable for all the uses of the ordinary article. When growing its aspect is that of a Lupine. It selects a dry, gravelly, but not barren soil." *Parry*.

The Dakota (Sioux) name of the river in western Minnesota, well known as the Pomme de Terre, refers to this plant. Riggs' *Dakota Dictionary*, p. 171.

DALEA, L. DALEA.

D. alopecuroides, Willd. Dalea.

Spirit lake, Iowa, *Geyer*; and doubtless in the adjoining portions of Minnesota. Southwest.

PETALOSTEMON, Michx. PRAIRIE CLOVER.

P. violaceus, Michx. Purple Prairie Clover.

Abundant in all the prairie portion of the state; extending northeast to the upper Mississippi river, *Houghton*.

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* HOSACKIA, Dougl. Calyx-teeth nearly equal. Petals free from the stamens, nearly equal; standard often remote from the rest, ovate or roundish; keel curved, obtuse or somewhat acutely beaked. Stamens diadelphous; anthers uniform. Pod linear, compressed or nearly terete, sessile, several-seeded, with partitions between the seeds. Herbaceous or rarely woody, with pinnate 2- to many-foliolate leaves; stipules mostly minute and gland-like; flowers in axillary sessile or pedunculate umbels, yellow, often becoming brownish.

HOSACKIA PURSHIANA, Benth. Annual, usually a foot high or more, and more or less silky-villous: leaflets 1 to 5, ovate to narrowly lanceolate, 2 to 9 lines long; stipules gland-like; flowers small, yellow, on peduncles exceeding the leaves, bracteate with a single leaflet; calyx-teeth linear, much exceeding the tube, about equalling the corolla; pod linear, straight, smooth, an inch long, 5- to 7-seeded. *Watson* in *Botany of Wheeler's Surveys west of the One Hundredth Meridian*.

P. candidus, Michx. White Prairie Clover.

Abundant, with same range as the last; excepting that it is less common in the north part of the Red river valley, *Upham.*

P. villosus, Nutt. Silky Prairie Clover.

Common on sandy land, from lake Pepin, *Miss Manning,* Goodhue county, *Sandberg,* and the barrens of the St. Croix river, *Parry,* to Minneapolis, Lac qui Parle, and Polk county, *Upham.*

AMORPHA, L. False Indigo.

A. fruticosa, L. False Indigo. "River Locust."

Common through the south half of the state, in the Red river valley, *Upham,* and to the upper Mississippi river, *Garrison.*

A. canescens, Nutt. Lead-Plant. "Shoe-strings."

Abundant, with the same range as the last. The common name alludes to its long tough roots, which are troublesome in plowing.

A. microphylla, Pursh.* (A. nana, Nutt.) Dwarf False Indigo.

Common from the Blue Earth river, *Parry,* and Chippewa, Swift and Grant counties, *Roberts,* southwestward; also common, or frequent, throughout the Red river valley, *Upham.*

ROBINIA, L. Locust-tree.

R. Pseudacacia, L. Common Locust-tree. False Acacia.

Adventive, Minneapolis, *Winchell.*

TEPHROSIA, Pers. Hoary Pea.

T. Virginiana, Pers. Goat's Rue. Catgut.

Lapham. Hart, Winona county, *Winchell;* at head of lake Pepin, *Sandberg,* Washington county, *Juni.* South.

ASTRAGALUS, L. Milk-Vetch.

A. caryocarpus, Ker. Ground Plum.

Common, often abundant in all the prairie portion of the state: extending northeast to the upper Mississippi river, *Garrison.* "When the pods, which are nearly solid, have reached the size of hazel-nuts, they prove a valuable addition to the list of early vegetables. Cooked like green peas, they make a pleasing dish, intermediate in taste and flavor between early peas and asparagus." *Arthur.*

A. Plattensis, Nutt., var. **Tennesseensis,** Gray. Ground Plum.

Grant county, *Roberts;* Fergus Falls, *Leonard.* Southwest.

A. Canadensis, L. Milk-Vetch.

Common, or frequent, throughout the state; abundant in the Red river valley, *Upham.*

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*Amorpha microphylla, Pursh. Nearly smooth, dwarf; leaves with very short petioles, obtuse at both ends; spikes short, solitary; calyx nearly naked, pedicellate, teeth all very acuminate; legumes 1-seeded. . . . . . From 1 to 2 feet high; flowers purple and fragrant. A very elegant little shrub. *Pursh's Fl. Amer.,* quoted by *Arthur* (*Contributions to the Flora of Iowa, No. V.*), who adds: "This compact little shrub is abundant on the dry prairies of northwestern Iowa. It flowers in May, and not in July and August as stated by Pursh. The leaflets are oblong, conspicuously punctate, and in 10—20 pairs."

A. adsurgens, Pall.[*] Milk-Vetch.

Red river valley, *Scott, Macoun.* West.

A. hypoglottis, L.[†] Milk-Vetch.

Plains near Pembina, *Douglas, Chickering, Havard.* Red river prairie. *Dawson.* West.

A. gracilis, Nutt.[‡] Milk-Vetch.

Minnesota. *Watson..* Southwest.

A. Cooperi, Gray. Cooper's Milk-Vetch.

Upper Mississippi river, *Garrison;* lake Pepin, *Miss Manning.* Rare.

A. flexuosus, Dougl.[§] Milk-Vetch.

Red river prairie, *Douglas, Macoun, Dawson, Scott.* West.

OXYTROPIS, DC. OXYTROPIS.

O. Lamberti, Pursh. Oxytropis.

Frequent or common, westward; extending east to Worthington (rare) *Foote,* Cottonwood county, *Holzinger,* Glenwood (common, with flowers bright rose-purple, changing later to blue), *Upham,* Douglas county, *Mrs. Terry,* Fergus Falls, *Leonard,* and the Red river valley, *Douglas, Macoun.*

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[*] ASTRAGALUS ADSURGENS, Pall. Perennial, cinereous with minute appressed pubescence or glabrate; stems rather stout, 4 to 18 inches high, ascending or decumbent; stipules scarious, mostly united at base; leaflets 10 pairs, 6 to 9 lines long, narrowly or linear-oblong; spike dense, at length oblong or cylindrical; flowers purplish, medium sized, ascending; calyx-tube rather long-campanulate, twice exceeding the setaceous teeth, subvillous with light or dark hairs; pod coriaceous, pubescent, sessile, ascending, ovate-oblong (4 to 5 lines in length), straight, usually triangular-compressed, with a dorsal sulcus, and 2-celled by the intruded dorsal suture, many-ovuled. *Watson's Rep. in King's Expl. of the Fortieth Parallel,* following *Gray's Revis., Proc. Amer. Acad.,* vol. vi.

[†] ASTRAGALUS HYPOGLOTTIS, L. Perennial, with a rather loose pubescence, or nearly glabrous; stems 6 inches to 2 feet long, slender, diffusely procumbent or ascending; stipules subfoliaceous and more or less sheathing; leaflets 7 to 10 pairs, oblong, obtuse or retuse; heads rather many-flowered; corolla violet, ½ inch long; legume coriaceous, ovate and triangular, silky-villous, very shortly stipitate, 2-celled by the intruded dorsal suture, and but 6- to 8-seeded. From southern Colorado northward along the Rocky Mountains and Red River Valley to the Arctic Circle and Alaska. June to September. *Watson's Rep. in King's Expl. of the Fortieth Parallel,* following *Gray's Revision.*

[‡] ASTRAGALUS GRACILIS, Nutt. Perennial, somewhat appressed pubescent, slender, erect or ascending, a foot high or more: leaflets three to five pairs, narrowly linear, half an inch long or less: flowers very small, white or purplish, in an elongated open long-peduncled spike: calyx-teeth very short: pods coriaceous, sessile, pubescent and rugose, 2 or 3 lines long, ovate-oblong and obcompressed, 1-celled, concave on the back, and the ventral suture prominent. *Watson* in *Botany of Wheeler's Surveys west of the One Hundredth Meridian.*

[§] ASTRAGALUS FLEXUOSUS, Dougl. Ashy-puberulent; stems ascending, 1 foot high, flexuose; leaflets oblong or cuneate-linear, obtuse or retuse; peduncles exceeding the leaves; racemes mostly elongated, loose; flowers 4 lines long, white or purplish; calyx hoary-pubescent, teeth three times shorter than the tube, pod cylindric, 8 to 11 lines long, 2 lines broad, puberulent, thinly coriaceous, straight or sub-incurved; stipe very short, but evident. *Gray's Revision of Astrag., Proc. Amer. Acad.,* vol. vi.

O. splendens, Dougl.* Silvery Oxytropis.

"A most elegant plant, with its crowded, silvery, silky-villous foliage and spikes, and deep blue corollas. It was gathered on the Chippewa river" [in Minnesota]. *Gray* in *Pacific Railroad Report.* Glenwood, Pope county, *Upham;* Pembina, *Douglas, Havard.* West.

GLYCYRRHIZA, Tourn. LICORICE.

G. lepidota, Pursh. Wild Licorice.

Abundant westward, from St. Vincent to Iowa; extending east to lake Pepin, *Miss Manning,* Freeborn county and Minneapolis, *Upham,* the St. Croix river, *Parry,* Stearns county, *Campbell,* and the lake of the Woods at the mouth of Rainy river, *Macoun;* but not reported in the region of the upper Mississippi river and farther northeast.

HEDYSARUM, Tourn. HEDYSARUM.

H. boreale, Nutt. HEDYSARUM.

Lapham. [North shore of lake Superior, *Agassiz.*] North.

DESMODIUM, DC. TICK-TREFOIL.

D. nudiflorum, DC. Tick-Trefoil.

St. Croix river, *Parry;* Anoka county, also New Ulm, *Juni;* Blue Earth county, *Gedge;* Redwood Falls, *Pemberton.* Infrequent. South.

D. acuminatum, DC. Tick-Trefoil.

Common southward; extending north to the upper Mississippi river, *Garrison;* Fergus Falls, *Leonard.*

D. rotundifolium, DC. Round-leaved Tick-Trefoil. Trailing Tick-Trefoil.

Upper Mississippi river, *Garrison.* Infrequent. South.

D. canescens, DC. Tick-Trefoil.

Otter Tail county, *Upham;* Nicollet county, *Aiton;* Blue Earth county, *Leiberg;* lake Pepin, *Miss Manning.* Infrequent. South.

D. cuspidatum, Hook. Tick-Trefoil.

Lapham. Upper Mississippi river, *Garrison.* Infrequent. South.

D. Dillenii, Darlingt. Tick-Trefoil.

Stearns county, *Garrison;* Douglas county, *Mrs. Terry;* Minneapolis, *Kassube;* Steele county (common), *Upham.* South.

D. paniculatum, DC. Tick-Trefoil.

Upper Mississippi river, *Garrison;* Winona county, *Holzinger;* Hesper, Iowa, *Mrs. Carter.* Infrequent. South.

D. Canadense, DC. Tick-Trefoil.

Common through the south half of the state, and perhaps northward; found at the lake of the Woods, *Dawson, Burgess,* and extending into Manitoba to the north end of lake Winnipeg, *Hooker.*

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*OXYTROPIS SPLENDENS, Dougl. Acaulescent, silvery, silky-villous throughout, 6 to 12 inches high; leaflets somewhat verticillate, 3 to 6 together, very numerous, lanceolate, very acute, usually 5 to 10 lines long; flowers in an oblong spike, erect, spreading, usually deep blue; peduncles exceeding the leaves; flowers not much surpassing the calyx; pod ovate, erect. *Porter and Coulter's Flora of Colorado.*

LESPEDEZA, Michx. BUSH-CLOVER.

L. repens, Barton. (Including L. procumbens, Michx.) Bush-Clover.
Lapham. Rare. South.

L. violacea, Pers. Bush-Clover.
Blue Earth county, *Leiberg;* Brown county, *Juni.* Infrequent. South.

[L. reticulata, Pers. (L. violacea, Pers., var. sessiliflora, Don) probably occurs in the south part of the state.

L. reticulata, Pers., var. **angustifolia,** Maxim. (L. violacea, Pers., var. angustifolia, Torr & Gray.) Bush-Clover.
Cottonwood county, *Holzinger.* Infrequent. South.

L. hirta, Ell. Bush-Clover.
Lake Pepin, *Miss Manning;* Cottonwood county, *Holzinger.* Infrequent. South.

L. capitata, Michx. Bush-Clover.
Common, or frequent, through the south half of the state; extending north at least to Cass county, *Upham.*

L. leptostachya, Engelm.* Bush-Clover.
Southeastern Minnesota, *T. J. Hale;* Emmet county, Iowa (common), *Cratty;* Rock county (common). *Leiberg.* South.

VICIA, Tourn. VETCH. TARE.

V. sativa, L. *Vetch.*
Lake Pepin, *Miss Manning.* Rare.

V. Cracca, L. Blue Vetch.
Minneapolis, and Carlton county, *Roberts;* White Bear, Ramsey county, *Miss Field.* Rare. South.

V. Caroliniana, Walt. Pale Vetch. Carolina Vetch.
Frequent through the south half of the state; extending north to the upper Mississippi river, *Garrison,* and Fergus Falls, *Leonard.*

V. Americana, Muhl. Purple Vetch. American Vetch.
Common throughout the state.

LATHYRUS, L. VETCHLING. EVERLASTING PEA.

L. maritimus, Bigelow. Beach Pea.
Common on beaches of gravel and sand, north shore of lake Superior, *Juni, Roberts;* lake of the Woods, *Dawson.*

L. venosus, Muhl. Vetchling.
Common through the south half of the state, and in the Red river valley; extending northeast to the upper Mississippi river, *Garrison,* and Kaministiquia river, *Macoun.*

L. ochroleucus, Hook. Pale Vetchling.
Common, often abundant, throughout the state.

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*LESPEDEZA LEPTOSTACHYA, Engelm. Clothed with appressed, silky pubescence; leaves linear; petiole longer than the terminal petiolule; spikes paniculate, slender, somewhat loosely flowered, rather longer than the peduncle; legume equal to or slightly longer than the calyx. . . . . . Has passed for L. angustifolia, from which its slender spikes and paniculate habit at once distinguish it. *Gray, Proc. Amer. Acad. of Arts and Sciences,* vol. xii.

L. paluster, L. Marsh Vetchling.

Common throughout the state.

L. paluster, L., var. **myrtifolius,** Gray. Marsh Vetchling.

Blue Earth county, *Leiberg;* Stearns county, *Campbell;* Fergus Falls, *Leonard.*

APIOS, Boerhaave. GROUND-NUT. WILD BEAN.

A. tuberosa, Moench. Ground-nut. Dakota Potato. Pomme de Terre.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river. "*Pomme de Terre* of the French voyageurs; *Mdo*, or wild potato, of the Sioux Indians." *Parry.*

PHASEOLUS, L. KIDNEY BEAN.

P. perennis, Walt. Wild Bean.

Saint Paul, *Kelley;* St. Croix Falls, *Miss Field;* upper Mississippi river, *Garrison;* Pembina, *Havard.*

P. diversifolius, Pers. Wild Bean.

Minneapolis, *Twining*; Blue Earth county, *Leiberg;* New Ulm, *Juni;* Emmet county, Iowa (rare), *Cratty.* Southeast.

P. pauciflorus, Benth. Wild Bean.

Frequent through the south half of the state; extending north to the head-waters of the Mississippi river, *Garrison.*

AMPHICARPÆA, Ell. HOG PEA-NUT.

A. monoica, Ell. Hog Pea-nut.

Common throughout the state, excepting perhaps far northward.

BAPTISIA, Vent. FALSE INDIGO.

B. tinctoria, R. Br. Wild Indigo.

Anoka county, and White Bear, Ramsey county, *Juni;* near Saint Paul, *Mrs. Terry;* lake Pepin, *Miss Manning.* Infrequent. Southeast.

B. leucantha, Torr. & Gray. White False Indigo.

Frequent through the south half of the state; extending north to the upper Mississippi river, *Garrison,* and Fergus Falls, *Leonard.*

B. leucophæa, Nutt. Yellowish Wild Indigo.

Common in the most southern counties across the state; extending north to lake Pepin, *Miss Manning,* Rice county, *Upham,* and Minneapolis, *Kassube.*

CERCIS, L. RED-BUD. JUDAS-TREE.

C. Canadensis, L. Red-bud. Judas-tree.

Southern Minnesota, *Sargent's Catalogue of Forest Trees, Tenth Census of U. S.* If found in this state, it must be rare or local, in the most southeastern counties.

CASSIA, L. Senna.

C. Chamæcrista, L. Partridge Pea. Sensitive Pea.

Frequent, or common, throughout the southern third of the state; less frequent farther north to the upper Mississippi river, *Houghton.*

GYMNOCLADUS, Lam. KENTUCKY COFFEE-TREE.

G. Canadensis, Lam. Kentucky Coffee-tree.

Houston county, near Dakota, Winona county, and Jordan, Scott county, *Winchell;* Lake City, *Miss Manning;* Nicollet county (forming groves in the woods opposite to Mankato; attaining a diameter of six inches; wood very hard, straight-grained, valuable), *Leiberg;* New Ulm, *Juni;* Sleepy Eye, Brown county, *Upham.* Infrequent. South.

DESMANTHUS, Willd. DESMANTHUS.

D. brachylobus, Benth. Desmanthus.

Swan lakes, northwestern Redwood county, *Upham;* Spirit lake, Iowa, *Geyer.* South.

ROSACEÆ. ROSE FAMILY.

PRUNUS, Tourn. PLUM, CHERRY, ETC.

P. Americana, Marshall. Wild Plum.

Common, often abundant, throughout the state. Usually from 10 to 20 feet high; but north of lake Superior seldom exceeding 12 feet in hight, and often fruiting at 3 or 4 feet, *Clark.* Fruit valuable, pleasant-flavored, rarely bitter, mostly purple, but not infrequently varying from that color to yellow.

P. pumila, L. Dwarf Cherry. Sand Cherry.

Common on sandy land through the north half of the state, and south to Minneapolis; local and rare farther south, as at Castle Rock and in Goodhue county, *Sandberg,* lake Pepin, *Miss Manning,* and section 33, Hart, Winona county, *Winchell.*

P. Pennsylvanica, L. Wild Red Cherry. Bird Cherry.

Common throughout the state, excepting southwestward, where it occurs rarely. Usually 15 to 30 feet high; but north of lake Superior its ordinary hight is about 12 feet, with a diameter of 2¼ inches, *Clark.*

P. Virginiana, L. Choke-Cherry.

Common throughout the state.

P. serotina, Ehrh. Wild Black Cherry.

Common throughout the state, excepting far northward, where it is absent or rare. *Macoun* reports it as far west as the Kaministiquia river, lake Superior.

NEILLIA, Don. NINE-BARK.

N. opulifolia, Benth. and Hook. (Spiræa opulifolia, L.) Nine-Bark.

Frequent throughout most of the state, but rare southward and westward; abundant north of lake Superior, especially along the shore, "clinging to bare rocks, often within the sweep of the waves," *Juni, Roberts;* Rainy river and lake of the Woods, *Macoun.*

SPIRÆA, L. MEADOW-SWEET. SPIRÆA.

S. salicifolia, L. Common Meadow-Sweet. Willow-leaved Spiræa. Queen of the Meadow.

Common throughout the state.

S. tomentosa, L. Hardhack. Steeple-Bush.

Frequent, in some places plentiful, in Hennepin, Anoka, Chisago, Isanti and Kanabec counties, *Roberts, Juni, Upham.* East. [It is also found at lake Winnipeg, *Richardson.*]

AGRIMONIA, Tourn. AGRIMONY.

A. Eupatoria, L. Common Agrimony.

Frequent, often common, throughout the state.

GEUM, L. AVENS. GEUM.

G. album, Gmelin. White Avens.

Frequent, or common, throughout the state; extending northward to the north shore of lake Superior, *Juni*, and Pembina, *Havard*.

G. Virginianum, L. Virginian Avens.

Minnesota river, *Parry;* Blue Earth county, *Leiberg;* Goodhue county, *Sandberg;* Hesper, Iowa, *Mrs. Carter*. Infrequent. South.

G. macrophyllum, Willd. Large-leaved Avens.

Abundant north of lake Superior, *Roberts;* extending south to Sherburne county, *Upham*, Anoka county and New Ulm, *Juni*, and lake Minnetonka, *Roberts*.

G. strictum, Ait. Strict Avens.

Throughout the state; common northward, frequent southward.

G. rivale, L. Water Avens. Purple Avens.

Common, or frequent, through the north half of the state; extending south to lake Pepin, *Miss Manning*, Northfield, Rice county, *Chaney*, and Nicollet county, *Aiton*.

G. triflorum, Pursh. Three-flowered Avens.

This species, "attractive by reason of its long, plumose styles, and dissected, fern-like leaves." rare in states farther east, is common, or frequent, on dry somewhat sandy land throughout Minnesota, excepting northeastward, in which direction it extends at least to the head of lake St. Croix, Brainerd, and the upper Mississippi river.

WALDSTEINIA, Willd. DRY OR BARREN STRAWBERRY.

W. fragarioides, Tratt. Barren Strawberry.

Stearns county, *Garrison;* St. Croix Falls and Stillwater, *Miss Field*. Infrequent. East.

POTENTILLA, L. CINQUE-FOIL. FIVE-FINGER. POTENTILLA.

P. Norvegica, L. Cinque-foil.

Common throughout the state.

P. supina, L. (P. paradoxa, Nutt.) Cinque-foil.

Lake Pepin, *Miss Manning;* sandy shores of lake Minnetonka, *Roberts, Herrick;* Anoka county and New Ulm, *Juni;* Martin county (rare), *Cratty;* Stearns county, *Garrison;* Grant county, *Roberts*. [Devil's lake, Dakota, *Geyer*, and northwestward.] South and west.

P. Canadensis, L. Common Cinque-foil or Five-Finger.

Common, or frequent, throughout the state, excepting perhaps far northward.

P. Canadensis, L., var. **simplex,** Torr. and Gray. Cinque-foil. Five-Finger.

Lake Pepin, *Miss Manning;* New Ulm, *Juni;* Emmet county, Iowa (rare), *Cratty;* Minneapolis (common), *Roberts;* Sherburne county (common), *Upham*. [North of lake Superior, *Agassiz*.]

P. argentea, L. Silvery Cinque-foil or Five-Finger.

Winona county, *Holzinger;* Saint Paul, *Miss Cathcart;* Minneapolis, *Herrick, Upham;* Washington county, *Leonard;* St. Croix Falls, *Miss Field;* Anoka county, *Juni;* near Green lake, Kandiyohi county, *Mrs. Terry.* [Sheyenne river, Dakota, *Geyer.*] Infrequent.

P. Pennsylvanica, L., var. **strigosa,** Pursh.* Cinque-foil. Potentilla.

Granite knolls beside the Minnesota river in the west part of Nicollet county, *Parry;* Redwood Falls, *Pemberton;* Worthington (common), *Foote;* Luverne, *Leiberg;* Pipestone quarry, *Mrs. Bennett;* Fergus Falls, *Leonard.* [Pembina mountain, Dakota, *Havard.* "The common form in the prairie region" of Manitoba, *Macoun*.] West.

P. Pennsylvanica, L., var. **bipinnatifida,** Torr. & Gray.** Cinque-foil.

Pipestone county, *Mrs. Bennett;* plains of the Red river, *Douglas, Macoun.* West.

P. Hippiana, Lehm. † Cinque-foil. Potentilla.

Plains of the Red river, *Drummond, Macoun.* West.

P. effusa, Dougl.‡ Cinque-foil. Potentilla.

Higher parts of the Red river valley, plentiful, *Douglas, Macoun.* West.

P. arguta, Pursh. Cinque-foil. Potentilla.

Common, often abundant, throughout the state.

P. Anserina, L. Silver-Weed.

Common, or frequent, throughout the north half of the state; extending south at least to Minneapolis and Murray county. *Upham.*

P. fruticosa, L. Shrubby Cinque-foil.

Abundant north of lake Superior, especially along its rocky shore, *Juni, Roberts*; also found near the Tamarack river in T. 158, R. 46, Marshall county, *Upham,* and at the eastern border of the Red river prairie near the international boundary, *Dawson, Scott.* (Not yet reported, but doubtless occurring rarely, in the south half of the state; found at Decorah, Iowa, *Arthur.*) North.

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* POTENTILLA PENNSYLVANICA, L., var. STRIGOSA, Pursh. Low, 6 to 15 inches high; stems erect, leafy, rather stout; leaves mostly tomentose on both surfaces, paler beneath, deeply pectinate-divided or pinnatifid, segments linear, entire, with revolute margins; stipules laciniate. *Porter and Coulter's Flora of Colorado,* following *Watson's Revis., Proc. Amer. Acad.,* vol. viii.

** POTENTILLA PENNSYLVANICA, L., var. BIPINNATIFIDA, Torr. & Gray. Leaflets crowded (3 to 5) and often almost palmate, deeply pinnatifid (silky-pubescent but not canescent above); the segments linear, elongated, mostly spreading. *Torrey and Gray's Flora of N. A.*

† P. HIPPIANA, Lehm. Densely white-tomentose and silky throughout; the upper surface of the leaves a little darker; stems ascending, 1 to 1½ feet high, slender, branching above into a diffuse cyme, stipules usually entire; leaves pinnate, occasionally digitate; leaflets 5 to 11, cuneate-oblong, 1 to 2 inches long, obtuse, incisely toothed, at least towards the apex, margins not revolute; pedicels slender; bractlets narrow; petals 2½ to 3½ lines long, exceeding the calyx; styles filiform, not glandular at base, terminal; carpels 10 to 30. *Porter and Coulter's Flora of Colorado,* following *Watson's Revision.*

‡ P. EFFUSA, Dougl. Canescently tomentose with scattered villous hairs; stems ascending, diffusely branched above, 4 to 12 inches high; stipules lanceolate, entire or incised; leaflets 5 to 11, interruptedly pinnate, the alternate ones often smaller, cuneate-oblong, coarsely incised-serrate or dentate, the smaller leaflets 3- to 5-toothed; pedicels slender; sepals and the much smaller bractlets acuminate, 2 to 3 lines long, equaling or exceeding the obcordate petals; carpels 10. *Porter and Coulter's Flora of Colorado,* following *Watson's Revision.*

P. tridentata, Sol. Three-toothed Cinque-foil.

Frequent through the north part of the state; common along the rocky north shore of lake Superior and on Minnesota Point, at the last named locality growing in the dry loose sand, *Roberts, Juni*; infrequent, or rare, southward to Stearns county, *Mrs. Blaisdell*, White Bear, Ramsey county, *Miss Field*, Lake City, *Mrs. Ray*, and Hesper, Iowa, *Mrs. Carter*.

P. palustris, Scop. Marsh Five-Finger.

Throughout the state; common northward, frequent southward.

FRAGARIA, Tourn. STRAWBERRY.

F. Virginiana, Duchesne. Wild Strawberry.

Common throughout the state.

F. Virginiana, Duchesne, var. **Illinoensis,** Gray. Wild Strawberry.

Dakota county, *Winchell;* Anoka and Sherburne counties (common), *Upham;* abundant in Martin county (and in Emmet county, Iowa), *Cratty*.

F. vesca, L. Wild Strawberry. Wood Strawberry.

Mostly in woods; common through the north half of the state and southwestward, frequent southeastward.

RUBUS, Tourn. BRAMBLE.

R. Dalibarda, L. (Dalibarda repens, L.) Dalibarda.

Lapham. Green Lake, Kandiyohi county, *Mrs. Terry*. Rare. East.

[R. odoratus L., which occurs in northern Michigan and Wisconsin, probably does not extend into Minnesota.]

R. Nutkanus, Mocino. White Flowering-Raspberry.

Abundant north of lake Superor, *Juni, Roberts;* and extending to the sources of the Mississippi, *Houghton*. "Its showy white blossoms are about as large as those of the wild rose. The fruit is large and looks tempting but has a peculiar acid flavor, which makes it inferior to that of Rubus strigosus." *Juni*. North.

R. arcticus, L.* Arctic Raspberry.

Peat bog, "northwest angle" of the lake of the Woods, *Macoun*. North.

R. triflorus, Richardson. Dwarf Raspberry.

Common, or frequent, through the north half of the state; extending south to New Ulm, *Juni*, Blue Earth county, *Leiberg*, and Hesper, Iowa, *Mrs. Carter*.

R. strigosus, Michx. Wild Red Raspberry.

Common throughout the state, excepting southwestward, where it occurs less frequently; very abundant northward.

R. occidentalis, L. Black Raspberry. Black-cap Raspberry. Thimbleberry.

Common through the south half of the state, and north to the White Earth reservation, the upper Mississippi river, and Pine county; rare or wanting northeastward. A variety bearing cream-colored fruit occurs on the bluffs of the Mississippi at Winona, *Winchell*.

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*RUBUS ARCTICUS, L. Stem low, herbaceous, sometimes diœcious, unarmed, somewhat pubescent, mostly erect, 1- to 2-flowered, leaves trifoliolate; leaflets rhombic-ovate or obovate, coarsely and often doubly serrate, petiolulate; stipules ovate; sepals lanceolate, acute, often shorter than the obovate entire or emarginate (reddish) petals. *Torrey and Gray's Flora of N. A.*

R. villosus, Ait. High Blackberry.

Frequent, occasionally plentiful, throughout most of the state; but rare or wanting in some districts, especially southwestward and far northwest. Local.

R. villosus, Ait., var. **frondosus,** Torr. High Blackberry.

Between lake Superior and lake Winnipeg, *Richardson* (*Macoun*).

R. Canadensis, L. Low Blackberry. Dewberry.

Frequent, or common, through the east part of the state, extending west to Blue Earth county, *Leiberg*, Fergus Falls, *Leonard*, and the White Earth reservation, *Garrison;* north of lake Superior, *Agassiz, Macoun.*

R. hispidus, L. Running Swamp-Blackberry.

Similar in range with the last. Minneapolis, *Griswold*; Sherburne county (common), *Upham;* Fergus Falls, *Leonard;* upper Mississippi river, *Garrison.*

ROSA, Tourn. ROSE.

R. Carolina, L. Swamp Rose.

Houston county, *Winchell;* Blue Earth county, *Leiberg*; Northfield, *Chaney;* Morrison county, *Miss Babbitt.* Infrequent.

R. parviflora, Ehrh. (R. lucida, in *Manual.*) Dwarf Wild-Rose.

North of lake Superior (common), *Roberts;* White Earth reservation, *Garrison;* Kanabec county (common), *Upham*; St. Croix Falls, *Miss Field;* Hennepin and Fillmore counties, *Winchell;* Rice county, *Sperry;* Goodhue county, *Blake, Sandberg.*

R. blanda, Ait., var. **pubescens,** Crépin.* Early Wild Rose.

Common, often abundant, in all parts of the state; the only species of rose (but occurring in two varieties) in our prairie region, there varying in hight from about one foot, or sometimes two feet on the prairie, to three or four feet in groves and thickets, or even six feet, according to *Roberts*, in Grant county.

R. blanda, Ait., var. **setigera,** Crépin.† Early Wild Rose.

Specimens collected in Minneapolis are referred by *Watson* to this variety, which probably occurs, less frequently than the preceding, throughout the state, being most common northward.

CRATÆGUS, L. HAWTHORN. WHITE THORN.

C. coccinea, L. Scarlet-fruited Thorn.

Frequent, occasionally common, through most of the state; extending "north to the international boundary, but not much beyond it," *Bell.* [Emerson and Winnipeg, Manitoba, *Dawson, Macoun.*]

C. tomentosa, L. Black Thorn. Pear Thorn.

Common, or frequent, throughout the state.

C. tomentosa, L., var. **pyrifolia,** Gray. Black or Pear Thorn.

Olmsted county, *Winchell;* American portage, near the international boundary west of lake Superior, *Macoun.*

C. tomentosa, L., var. **punctata,** Gray. Black or Pear Thorn.

Martin county, *Cratty;* Olmsted county and lake Minnetonka, *Winchell;* Minneapolis, *Upham;* Pembina, *Chickering.* Perhaps the typical species is less common than these varieties.

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*ROSA BLANDA, Ait., var. PUBESCENS, Crepin. Leaflets more or less pubescent on the under side; upper part of the stems, as well as the branches and flowering branchlets, unarmed or nearly so. *Crepin's Monograph.*

†ROSA BLANDA, Ait., var. SETIGERA, Crepin. Leaflets glabrous or pubescent on the under side; stem not ordinarily more than a foot high, entirely covered with setaceous prickles. *Crepin's Monograph.*

C. subvillosa, Schrader. (C. tomentosa, L., var. mollis, Gray.) Downy Thorn.

Blue Earth county (common, becoming a tree twenty feet high), *Upham;* New Ulm, *Juni;* Emmet county, Iowa (rare), *Cratty;* Pipestone quarry, *Mrs. Bennett.* [North of lake Superior, *Bell, Macoun.*]

C. Crus-galli, L. Cockspur Thorn.

Winona, Fillmore, Mower, Freeborn and Scott counties, and the Big Woods, *Winchell;* lake Pepin, *Miss Manning;* Dodge county, *Harrington;* Rice county, *Sperry;* Hennepin county, *Simmons;* Fish-hook lake, Cass county, and the White Earth reservation, *Garrison.* ["In Manitoba a thorn which appears to be identical with this species is abundant." *Bell.*]

PIRUS (Pyrus), L. PEAR. APPLE.

P. coronaria, L. American Crab-Apple.

Common in the southeast part of the state; extending west to the Big Woods, and north to Ramsey and Hennepin counties, *Winchell,* and to Crow lake in southwestern Stearns county, *Upham.* The fruit, though bitterish, is frequently used for sauce.

P. arbutifolia, L. Choke-berry.

Frequent from Olmsted county, *Harrington,* and Faribault, *Miss Beane,* to Minneapolis, *Roberts,* Anoka county, *Juni,* and the St. Croix river, *Parry.* East.

P. arbutifolia, L., var. **melanocarpa,** Hook. Choke-berry.

Pine county (common), *Upham;* north of lake Superior, extending west to Sturgeon lake, Dawson route, *Macoun.* East.

P. Americana, DC. American Mountain-Ash.

Common through the north part of the state: extending south to northern Pine county, and to Mille Lacs. "A common tree north of lake Superior, attaining considerable size. *Professor Winchell* collected specimens where the trunk was at least 12 inches in diameter, and perfectly sound. Others, though unsound, were 15 and 16 inches." *Roberts.*

P. sambucifolia, Cham. & Schlecht. Elder-leaved Mountain Ash.

Common northward; extending south to Itasca lake, *Garrison,* and T. 137, R. 33, Wadena county, *Upham;* and rare farther south, as on the bluffs of the Mississippi at Winona, *Winchell.*

AMELANCHIER, Medic. JUNE-BERRY.

A. Canadensis, Torr. & Gray. (Including the var. Botryapium, Torr. & Gray.) Shad-bush. Service-berry.

Common throughout the state. (Usually from 10 to 30 feet high, but northeastward only attaining a hight of 10 feet and diameter of 2½ inches; used by the Indians for snow-shoe frames. *Clark.*)

A. Canadensis, Torr. & Gray, var. **oblongifolia,** Torr. & Gray. Service-berry.

Common, or frequent, throughout the state.

A. Canadensis, Torr. & Gray, var. **oligocarpa,** Torr. & Gray. Service-berry.

Loon portage, Dawson route (near the international boundary), *Macoun.* North.

A. alnifolia, Nutt. (A. Canadensis, Torr. & Gray, var. alnifolia, Torr. & Gray.) Western June-berry.

Pembina, *Chickering;* White Earth reservation, *Garrison;* Hennepin county, *Roberts;* Faribault, *Miss Beane;* Lake City, *Mrs. Ray.* Frequent.

SAXIFRAGACEÆ. SAXIFRAGE FAMILY.

RIBES, L. CURRANT. GOOSEBERRY.

R. Cynosbati, L. Prickly Wild Gooseberry.

Common, often abundant, throughout the state. Much used, (as also the following smooth species,) before fully ripening, for sauce.

[Of R. setosum, Lindl., Prof. Gray writes: "I suspect that this species inhabits the northwestern shore of lake Superior. Botanists visiting that district should look for a species with pure white flowers, a half inch or less in length, with cylindrical tube, and stamens decidedly shorter than the lobes. . . . It takes its name from the slender scattered prickles on the branches; but these are sometimes wanting, this being an inconstant character in all the species. The young berries are either perfectly smooth and naked, or beset with a few bristly prickles. This is the R. oxyacanthoides of Hooker's Flora, but certainly not of Linnæus. It belongs to the Saskatchewan region, extending into Montana and Wyoming." *American Naturalist*, vol. x, pp. 271-2.

R. oxyacanthoides, L. (R. hirtellum, Michx.) Smooth Wild Gooseberry.

Common throughout the state, excepting perhaps southward, in which direction it extends at least to Goodhue county, *Sandberg*, Faribault, *Miss Beane*, and Fergus Falls, *Leonard*.

R. rotundifolium, Michx. Smooth Wild Gooseberry.

Notes by observers using Gray's *Manual* give this as common through the south half of the state, and less frequent northward to the St. Louis river, *Mrs. Herrick*, and Grand Marais, north of lake Superior, *Roberts*. Further investigation is needed, however, to decide whether R. rotundifolium occurs in Minnesota. Just as this is being printed, I learn from Mr. Arthur that Prof. Gray decides specimens of the common smooth wild gooseberry in Iowa (before regarded as R. rotundifolium) to be R. gracile, Michx. "R. rotundifolium Michx. is a species of the Alleghany Mountains, ranging northward and eastward into New York and the western borders of Massachusetts." (*Gray* in *American Naturalist*, vol. x.) Probably most, or perhaps all, of the supposed observations of this species in Minnesota belong instead to the next.

R. gracile, Michx. (R. Missouriense, Nutt.)* Missouri Gooseberry.

Lapham. See remarks under the preceding species.

R. lacustre, Poir. Swamp Wild Gooseberry.

Lapham. North of lake Superior, *Juni*, *Roberts*. North.

R. prostratum, L'Her. Fetid Currant. Skunk Currant.

Common north of lake Superior, *Juni*, *Roberts*; St. Louis river, *Mrs. Herrick;* upper Mississippi river, *Garrison*. North.

R. floridum, L'Her. Wild Black Currant.

Common, or frequent, throughout the state.

R. rubrum, L. Red Currant.

Frequent through the north half of the state; extending south to southeastern Pine county and Benton county, *Upham*, Fish-hook lake, Cass county, *Garrison*, and Fergus Falls, *Leonard*.

R. aureum, Pursh. *Buffalo Currant. Missouri Currant.*

Escaped from gardens: Mankato, *Leiberg;* Minneapolis, *Kassube*.

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*RIBES GRACILE, Michx. Flowers 1 to 4 on the slender peduncle, white or whitish, narrow, with calyx-lobes longer than the tube and shorter than the half-inch stamens; filaments almost capillary, generally connivent or closely parallel, and soon conspicuously longer than the oblong-linear calyx-lobes; flower with barely a slight tinge of green; berry smooth, large, purple, prized in cultivation under the name of Missouri Gooseberry. It ranges from Tennessee and Illinois to the northern borders of Texas, and northwestward into the Rocky Mountains. *Gray* in *American Naturalist*, vol. x.

PARNASSIA, Tourn. GRASS OF PARNASSUS.

P. parviflora, DC. Grass of Parnassus.

North shore of lake Superior, *Macoun*.

P. palustris, L. Grass of Parnassus.

North shore of lake Superior, *Juni;* Fort Francis, Rainy river, *Macoun;* common in the Red river valley, along the Pembina and Fort Garry trails, from Tamarack river northward into Manitoba, *Upham;* extending southward to Stearns county, *Garrison, Mrs. Blaisdell.*

P. Caroliniana, Michx. Grass of Parnassus.

Common through the south half of the state, and north to the upper Mississippi river, *Garrison*, and Polk county, *Upham;* also, lake of the Woods, *Burgess* (*Macoun*), and between the lake of the Woods and Red river, "probably about the northwestern limit of the species," *Dawson;* Pembina, *Havard.*

SAXIFRAGA, L. SAXIFRAGE.

S. tricuspidata, Retz. Saxifrage.

North shore of lake Superior, doubtless in Minnesota ; Isle Royale, *Whitney*.

S. Aizoon, Jacq. Saxifrage.

North shore of lake Superior, *Macoun, Ellis;* Isle Royale, *Whitney*.

S. Virginiensis, Michx. Early Saxifrage.

Lapham. Hastings, Dakota county, *Mrs. Ray*. Rare.

S. Pennsylvanica, L. Swamp Saxifrage.

Common, or frequent, throughout the state.

SULLIVANTIA, Torr. & Gray. SULLIVANTIA.

S. Ohionis, Torr. & Gray. Sullivantia.

Rock bluffs of the Mississippi river, near Dakota, Winona county, *Winchell*. Rare.

HEUCHERA, L. ALUM-ROOT.

H. Americana, L. Common Alum-root.

St. Louis river, *Houghton;* Cass lake, *Schoolcraft;* Stearns county, *Campbell;* Stillwater, *Miss Field;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning;* Winona county, *Holzinger*. Infrequent.

H. hispida, Pursh. Alum-root.

Common through the south half of the state, and in the Red river valley ; extending northeast to the lake of the Woods. *Dawson*, the east end of Rainy lake, *Macoun*, and the upper Mississippi river, *Garrison.*

MITELLA, Tourn. MITER-WORT. BISHOP'S-CAP.

M. diphylla, L. Two-leaved Miter-wort.

Common, or frequent, through the south half of the state ; extending north at least to Fergus Falls, *Leonard*, Saint Cloud, *Campbell*, and the north shore of lake Superior, *Agassiz.*

M. nuda, L. Naked Miter-wort.

Common through the north half of the state ; extending south at least to Stearns county, *Campbell*, and Minneapolis, *Roberts.*

TIARELLA, L. FALSE MITER-WORT.

T. cordifolia, L. False Miter-wort.

Lapham. Lake City, *Miss Beane;* Blue Earth county, *Gedge.* Infrequent.

CHRYSOSPLENIUM, Tourn. GOLDEN SAXIFRAGE.

C. Americanum, Schwein. Golden Saxifrage.

Lake Superior to the Mississippi, *Houghton,* Stearns county, *Mrs. Blaisdell.* Infrequent. North.

CRASSULACEÆ. ORPINE FAMILY.

PENTHORUM, Gronov. Ditch Stone-crop.

P. sedoides, L. Ditch Stone-crop.

Common, or frequent, through the south part of the state; extending north to the upper Mississippi river, *Garrison.*

SEDUM, Tourn. STONE-CROP. ORPINE.

S. Telephium, L. *Garden Orpine. Live-for-ever.*

Occasionally escaped from cultivation, Minneapolis, *Upham.*

HAMAMELACEÆ. WITCH-HAZEL FAMILY.

HAMAMELIS, L. WITCH-HAZEL.

H. Virginiana, L. Witch-Hazel.

Lapham. Southeastern Winona county, between Richmond and Dakota, *Winchell.* Rare. Southeast.

HALORAGEÆ. WATER-MILFOIL FAMILY.

MYRIOPHYLLUM, Vaill. WATER-MILFOIL.

M. spicatum, L. Water-Milfoil.

Frequent, or common, throughout the state.

M. verticillatum, L. Water-Milfoil.

Lapham. Blue Earth county, *Leiberg.* [In Manitoba, *Macoun.*] Infrequent.

M. heterophyllum, Michx. Water-Milfoil.

Lapham. Common southwestward, *Upham.*

[Proserpinaca palustris, L., has not yet been observed, but it probably occurs in this state.]

HIPPURIS, L. MARE'S-TAIL.

H. vulgaris, L. Mare's-Tail.

Frequent, often common, through the north half of the state; extending south at least to Little Falls (plentiful), *Upham,* Stearns county (abundant), *Mrs. Blaisdell,* and the Minnesota river near Traverse des Sioux, *Parry.*

ONAGRACEÆ. EVENING-PRIMROSE FAMILY.

CIRCÆA, Tourn. ENCHANTER'S-NIGHTSHADE.

C. Lutetiana, L. Tall Enchanter's-Nightshade.

Common throughout the state.

C. alpina, L. Low Enchanter's-Nightshade.

Common through the north half of the state; extending south at least to Anoka county, *Juni*, Minneapolis, *Herrick*, and Lake City, *Mrs. Ray*.

GAURA, L. GAURA.

G. biennis, L. Gaura.

Lake Pepin, *Miss Manning*. Southeast.

G. coccinea, Nutt.* Gaura.

Herman, Grant county, *Upham, Roberts;* ridge east of the Red river, near the international boundary (infrequent), *Scott;* plains of the Red river, *Drummond, Douglas*. West.

EPILOBIUM, L. WILLOW-HERB.

E. spicatum, Lam. (E. angustifolium, L.) Great Willow-herb. Fire-weed.

Common, or frequent, through the forest portion of the state; conspicuous on tracts of burned woodland. A canescent variety, besides the type, occurs at the lake of the Woods, *Dawson*.

E. origanifolium, Lam. (E. alpinum, L., var. majus, Wahl.) Willow-herb.

Winona county, *Holzinger;* Minneapolis, *Kassube;* Minneopa Falls, Blue Earth county, *Leiberg*. Rare southward, but probably frequent northward.

E. palustre, L., var. **lineare,** Gray. Linear-leaved Epilobium.

Common, or frequent, through the north half of the state, and southwestward; rare southeastward.

E. molle, Torr. Downy Willow-herb.

Blue Earth county, *Leiberg*; Minneapolis, *Simmons;* Anoka county, *Juni*. Infrequent.

E. coloratum, Muhl. Willow-herb.

Common throughout the state, especially northward.

ŒNOTHERA, L. EVENING-PRIMROSE.

Œ. biennis, L. Common Evening-Primrose.

Common throughout the state.

Œ. biennis, L, var. **grandiflora,** Lindl.

At the northwest side of Mille Lacs, *Upham*. [The var. muricata, Lindl., also quite certainly occurs in this state.]

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*GAURA COCCINEA, Nutt. Canescent, puberulent or glabrate; stems suffructicose and fastigiately branched from the base, 6 to 12 inches high, very leafy, ascending; leaves lanceolate, linear-oblong or linear, repand-denticulate or entire, 6 to 12 lines long, closely sessile; flowers in simple spikes terminating the leafy branches, rose-color, turning to scarlet; bracts linear, rather persistent, longer than the ovaries; calyx-segments linear-oblong, shorter than the narrow infundibuliform tube, as long as the roundish, unguiculate petals; fruit elliptical, sessile, short, terete, 4-sided above. *Porter and Coulter's Flora of Colorado.*

Œ. rhombipetala, Nutt. Evening-Primrose.

Frequent through the south part of the state; extending north to Minneapolis, *Roberts*, Anoka county, *Jupi*, and Stearns county, *Garrison*; but not found in the Red river valley, *Upham.*

Œ. fruticosa, L. Sundrops.

Upper Mississippi river, *Garrison.* Rare. South.

Œ. pumila, L. (Including Œ. chrysantha, Michx.) Small Evening-Primrose.

Throughout the state, but infrequent. Lake of the Woods *Dawson*, *Burgess;* upper Mississippi river, *Garrison;* Goodhue county, *Sandberg;* Lake city, *Mrs. Ray;* Hesper, Iowa, *Mrs. Carter;* Pipestone county, *Mrs. Bennett.*

Œ. serrulata, Nutt. Evening-Primrose.

Common in all the prairie portion of the state; abundant in the Red river valley; extending northeast to the upper Mississippi, *Houghton.*

Œ. albicaulis, Nutt.* White, shrubby Evening-Primrose.

Brown's Valley (petals white, 1 inch long), *Upham;* near Muskoda, Clay county, *Leiberg*; Pembina, *Havard.* West.

LUDWIGIA, L. False Loosestrife.

L. polycarpa, Short & Peter. False Loosestrife.

Lake Pepin, *Miss Manning;* White Bear lake, Ramsey county, *Simmons.* Rare. Southeast.

L. palustris, Ell. Water Purslane.

St. Croix river, *Parry;* Blue Earth county, *Leiberg.* [Saskatchewan river, *Richardson.*] Infrequent.

LYTHRACEÆ. Loosestrife Family.

DIDIPLIS, Raf. Didiplis.

D. linearis, Raf. (Ammannia Nuttallii, Gray.) Didiplis.

Minnesota, *T. J. Hale*, in Gray's *Manual.* Southeast.

LYTHRUM, L. Loosestrife.

L. alatum, Pursh. Loosestrife.

Common, or frequent, through the southern third of the state; extending north to Stearns county, *Mrs. Blaisdell,* and the upper Mississippi river, *Garrison.*

[Nesæa verticellata, HBK., which occurs on the upper St. Croix river in Wisconsin, should be looked for in the adjoining part of Minnesota.]

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*Œnothera albicaulis, Nutt. Perennial, puberulent or hirsute; stems usually 1 to 3 feet high, erect or ascending, with a white, membranous, shining bark; leaves very variable, linear or lanceolate, attenuate at the base, entire or more or less dentate; petals round-ovate, more or less unguiculate, entire, exceeding the stamens and equaling the pistil, often nearly white; capsule thickened at base, sessile, linear, divaricate, often flexuous or deflexed; seeds rather small, linear-lanceolate, smooth. *Porter and Coulter's Flora of Colorado.*

CACTACEÆ. CACTUS FAMILY.

OPUNTIA, Tourn. PRICKLY PEAR. INDIAN FIG. "CACTUS."

O. Rafinesquii, Engelm. Prickly Pear.

On rocks: at Taylor's Falls, *Miss Field*, *Miss Cathcart*; in section 17, Haven, Sherburne county, *Upham*; Redstone, near New Ulm, *Juni*. Rare. South. (The "prickly pear" which Keating and Sir John Richardson mention as abundant on the islands of the lake of the Woods is probably Echinocystis lobata. *Macoun*.)

O. Missouriensis, DC. Prickly Pear.

Section 17, Omro, Yellow Medicine county, *Upham*; Pipestone county (plentiful at the pipestone quarry), *Mrs. Bennett*, determined by *Dr. Engelmann*. Rare. South.

O. fragilis, Haw.* Prickly Pear.

Plentiful at the pipestone quarry, Pipestone county ("joints small, terete, with a terminal habit of growth, making them somewhat like a string of beads"), *Mrs. Bennett*, determined by *Dr. Engelmann*; Redwood Falls, *Miss Butler*. Rare. Southwest. (The range of this species is principally westward, on the upper Missouri and Yellowstone and thence south; but it occurs very rarely and locally farther east, being reported by *Swezey*, at Baraboo, Wisconsin.)

CUCURBITACEÆ. GOURD FAMILY.

SICYOS, L. ONE-SEEDED STAR-CUCUMBER.

S. angulatus, L. One-seeded Star-Cucumber.

Frequent through the south part of the state; extending north to St. Croix Falls, *Miss Field*, and Stearns county, *Garrison*.

ECHINOCYSTIS, Torr. & Gray. WILD BALSAM-APPLE.

E. lobata, Torr. & Gray. Wild Balsam-apple.

Common, or frequent, through the south half of the state, and in the Red river valley; extending northeast to Mille Lacs, *Upham*, the upper Mississippi river, *Garrison*, the lake of the Woods, *Dawson*, and Fort Francis, Rainy river, *Macoun*.

UMBELLIFERÆ. PARSLEY FAMILY.

HYDROCOTYLE, Tourn. WATER PENNYWORT.

H. Americana, L. Water Pennywort.

Lapham. Falls of the St. Croix, *Parry*. East.

H. umbellata, L. Water Pennywort.

North shore of lake Superior, *Juni*. Rare. East. [This species also occurs in Michigan.]

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*OPUNTIA FRAGILIS, Haw. The joints are small, ovate, compressed or turned, or even terete; 4 larger spines on the upper fully developed pulvilli cruciate, the upper one suberect, stouter and longer than the others, mostly yellowish-brown; on the lower margin 4-6 small white radiating spines; bristles few. Fruit apparently somewhat fleshy, getting dry much later with 20 to 28 pulvilli, almost naked, only the upper ones with a few short spines; seeds few, large, regular. *Engelmann and Bigelow*, in *Pacific Railroad Report*.

SANICULA, Tourn. SANICLE. BLACK SNAKEROOT.

S. Canadensis, L. Sanicle. Black Snakeroot.

Common, or frequent, through the south part of the state; extending north at least to Pine and Sherburne counties (common,) *Upham*, and Stearns county, *Campbell.*

S. Marylandica, L. Sanicle. Black Snakeroot.

Common, or frequent, throughout the state.

ERYNGIUM, Tourn. Eryngo.

E. yuccæfolium, Michx. Rattlesnake-Master. Button Snakeroot.

Common southeastward; extending north to Rice and Nicollet counties, and west to Martin county and the southeast part of Brown county, *Upham.*

DAUCUS, Tourn. CARROT.

D. Carota, L. *Common Carrot.*

Occasionally spontaneous: Nicollet county, *Aiton;* Lake City, *Miss Manning*.

CARUM, L. Caraway.

C. Carui, L.* *Common Caraway.*

"Self-seeding" northeastward, *Clark;* not infrequently adventive, Todd, Isanti and Steele counties, *Upham.*

POLYTÆNIA, DC. POLYTÆNIA.

P. Nuttallii, DC. Polytænia.

Lapham. Rare. South.

HERACLEUM, L. COW-PARSNIP.

H. lanatum, Michx. Cow-Parsnip.

Frequent throughout the state; abundant north of lake Superior.

PEUCEDANUM, L. PEUCEDANUM. HOG'S-FENNEL.

P. nudicaule, Nutt.† Peucedanum. Hog's-Fennel.

Rock county, *Leiberg;* extending northeast to Saint Cloud, Stearns county (bluff of Mississippi river, near the Normal School) *Mrs. Blaisdell*, determined by *Prof. Asa Gray.* "Abundant on gravelly drift knolls in southwestern Minnesota and northwestern Iowa; remarkable for being the earliest flowering plant of that region, blooming almost as soon as the snow has disappeared." *Leiberg.* Southwest.

**Carum Carui*, L. Finely pinnately compound leaves; stem-leaves with slender but short thread-shaped divisions; white flowers; oblong, highly aromatic fruit. *Gray's Field, Forest, and Garden Botany.*

†PEUCEDANUM NUDICAULE, Nutt. Caulescent or sometimes scarcely so, minutely pruinose-pubescent, 3 to 15 inches high; leafy only at base; leaves bipinnate or ternate-bipinnate, the segments incisely lobed with usually rather broad and subacute divisions; umbel somewhat capitate in flower, with 8 to 12 rays; involure none; involucels unilateral, of 6 to 10 membranously margined, more or less united bracts; petals white, with attenuated apex and quasi-obcordate; calyx-teeth short; fruit pubescent, broadly oval, 3 to 4 lines long and 3 lines broad, the thickish wing more than half as wide as the seed; vittæ 3 in the intervals, 6 upon the commissure, conspicuous; seed flattened. . . . . . As observed by Dr, Gray, the plant does not accord with Nuttall's description, nor in all respects with the characters of the genus; the lateral wings, however, are contiguous until the full maturity of the seed. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

PASTINACA, Tourn. PARSNIP.

P. sativa, L. (*Peucedanum sativum*, Benth. & Hook.) *Common Parsnip.*

Occasionally adventive throughout the state. [Common in Manitoba, *Macoun.*]

ARCHEMORA, DC. COWBANE.

A. rigida, DC. Cowbane. Water Dropwort.

Upper Mississippi river, *Garrison;* Wabasha, *Gibson;* Hesper, Iowa, *Mrs. Carter.* (The var. ambigua, Torr. & Gray, probably also occurs in Minnesota. *Arthur.*) Infrequent. South.

CYMOPTERUS, Raf. Cymopterus.

C. glomeratus, Raf.* Cymopterus.

"Bend of Red river" [at Breckenridge], *Lapham* (according to his ticket of specimens in the herbarium of Harvard college, *Watson*). West.

ARCHANGELICA, Hoffm. ARCHANGELICA.

A. hirsuta, Torr. & Gray. Archangelica.

Anoka county, *Juni;* lake Pepin, *Miss Manning.* Rare. South.

A. atropurpurea, Hoffm. Great Angelica.

Common, or frequent, through the north half of the state, excepting perhaps far northwestward; found in Clay county in the Red river valley, *Gedge;* extending south to lake Pepin, *Miss Manning*, Cannon River Falls, *Blake, Sandberg*, and New Ulm, *Juni.*

SELINUM, L. HEMLOCK-PARSLEY.

S. Canadense, Michx. (Conioselinum Canadense, Torr. & Gray.) Hemlock-Parsley.

Upper Mississippi river, *Garrison.* Rare.

ÆTHUSA, L. FOOL'S PARSLEY.

Æ. Cynapium, L. Fool's Parsley.

Near Lake City, *Miss Manning;* Nicollet county, *Aiton.* Rare. South.

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*CYMOPTERUS, Raf. Calyx-teeth rather prominent and setaceous or lanceolate, minute or obsolete. Petals ovate, oblong or oblanceolate, inflexed, quasi-emarginate. Disk flattened around the styles, undulate-margined. Fruit ovate or elliptical, obtuse or retuse, subterete or slightly compressed dorsally; carpels semi-terete; ribs thick and elevated, all or only the lateral ones or those opposite to the calyx-teeth expanded into wings; vittæ numerous, narrow. Carpophore 2-parted, free or attached to the carpels. Seeds much compressed dorsally and more or less concave on the face.—Perennial and subcæspitose, with a thickened caudex; leaves pinnately decompound, with narrow, small or incisely pinnatifid segments; umbels compound, usually few-rayed; involucral bracts 1 to 2 or none; of the involucels several, very narrow or broad and membranous; flowers white or yellow. *Benth. & Hook.*

CYMOPTERUS GLOMERATUS, Raf. Root thick and fusiform; plant 3 to 8 inches high; caudex about 1 inch high, sometimes divided, bearing the leaves and peduncles at the summit; leaves on long petioles ternately divided and bipinnatifid, segments oblong-linear; rays of the umbel 4 to 6, very short; peduncles much shorter than leaves, 6 to 12 lines long; flowers white, those of the center abortive, pedicellate; leaflets of the palmately 5- to 7- parted involucel coherent at base and partly adnate to the rays of the umbellets; calyx-teeth subulate; fruit elliptical, 4 lines long, wings thickened and somewhat spongy, more or less obsolete; vittæ in each interval 3 or 4, in the commissure about 8. *Porter and Coulter's Flora of Colorado.*

THASPIUM, Nutt. MEADOW-PARSNIP.

T. barbinode, Nutt. Meadow-Parsnip.

Blue Earth river, *Parry*; Minneapolis, *Roberts*, *Upham*; extending north to the upper Mississippi river, *Garrison*. South.

T. aureum, Nutt. Meadow-Parsnip.

Common through the south half of the state; extending north to the upper Mississippi river, *Garrison*, and Sand Hill river, *Upham*; Pembina, *Chickering*, *Havard*.

T. aureum, Nutt., var. **apterum,** Gray. Meadow-Parsnip.

Minnesota river, *Parry*; abundant in Martin county, and in Emmet county, Iowa, *Cratty*. Perhaps the more common form of the species. South.

T. trifoliatum, Gray. Meadow-Parsnip.

Common through the south half of the state and northwestward; extending northeast to the upper Mississippi river, *Garrison*.

T. trifoliatum, Gray, var. **apterum,** Gray. Meadow-Parsnip.

Common throughout the Red river valley (the prevailing representative of this genus north of Sand Hill river), *Upham*; and common in Emmet county, Iowa, *Cratty*. Probably the most frequent form of the species in this state. (The var. atropurpureum, Gray, doubtless also occurs here, but must be rare.)

PIMPINELLA, L. BURNET SAXIFRAGE. GOLDEN ALEXANDERS.

P. integerrima, Benth. & Hook. (Zizia integerrima, DC.) Golden Alexanders.

Winona county, *Holzinger*; lake Pepin, *Miss Manning*; Faribault, *Miss Beane*; Martin county (plentiful), *Cratty*; Red river valley near Moorhead, *Leiberg*. Local.

CICUTA, L. WATER-HEMLOCK.

C. maculata, L. Spotted Cowbane. Musquash Root. Beaver-Poison.

Common, or frequent, throughout the state; abundant in the Red river valley. The roots of this and the following species are deadly poison.

C. virosa, L.* Water-Hemlock. Musquash-Poison.

Pembina, Red river valley ("this species exhibits forms running toward C. maculata,") *Chickering*; frequent from the Red river westward, on wet spots on the prairie, *Macoun*. Northwest.

C. bulbifera, L. Bulb-bearing Water-Hemlock.

Throughout the state; common northward, infrequent southward.

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*CICUTA VIROSA, L. Root-fibres slender. Rootstock short, hollow, with transverse partitions. Radical leaves bipinnate; ultimate leaflets or segments strapshaped-elliptical, entire or cleft, coarsely and unequally serrate. Stem erect, branched, hollow, 1 to 4 feet high. Lower leaves very large, triangular or lanceolate in outline, on thick, hollow petioles, with the pinnæ again pinnate; the secondary pinnæ undivided or 2- or 3-cleft or partite or pinnatifid, 1 to 3 inches long, varying in breadth from ⅛ to ⅝ inch; stem-leaves much smaller and less compound. Umbels flat-topped, lax, stalked, terminal or (from the growth of an axillary branch) opposite the leaves; rays of the umbels 1 to 2 inches long; pedicels ¼ to ⅜ inch long. Involucre none; involucel of numerous linear tapering leaves, shorter than the flowers. Flowers ⅛ inch across, white. Calyx-teeth ovate, much shorter than the petals, persistent. Petals roundish-obovate, spreading, slightly notched, with a small inflexed lobe. Cremocarp with the breadth greater than the length, which is one-tenth inch, reddish-brown, with the vittæ apparent when dry; ridges broad, little elevated; styles long, reflexed. *Sowerby's English Botany*, vol. iv.

SIUM, L. WATER-PARSNIP.

S. cicutæfolium, Gmelin. (S. lineare, Michx.) Water-Parsnip.
Common, or frequent, throughout the state.

BERULA, Koch. WATER-PARSNIP.

B. angustifolia, Koch. (Sium angustifolium, L.) Water-Parsnip.
Cold springs, Mankato and Kasota, *Leiberg*. Infrequent. South.

CRYPTOTÆNIA, DC. HONEWORT.

C. Canadensis, DC. Honewort.
Common through the south part of the state, extending north to the upper Mississippi river; Fond du Lac, at west end of lake Superior, *Mrs. Herrick*.

OSMORRHIZA, Raf. Sweet Cicely.

O. longistylis, DC. Smoother Sweet Cicely.
Common throughout the state.

O. brevistylis, DC. Hairy Sweet Cicely.
Frequent throughout the state.

CONIUM, L. POISON HEMLOCK.

C. maculatum, L. *Poison Hemlock.*
Red river valley near Saint Vincent, *Scott*. Infrequent.

ARALIACEÆ. GINSENG FAMILY.

ARALIA, Tourn. GINSENG. WILD SARSAPARILLA.

A. racemosa, L. Spikenard.
Frequent throughout most of the state; common in Todd, Stearns and Brown counties; rare far northward.

A. hispida, Vent. Bristly Sarsaparilla. Wild Elder.
Common along the north shore of lake Superior, *Roberts*, *Juni*; extending south to the Falls of the St. Croix, *Parry*, and to Dakota county (frequent), *Upham*. Northeast

A. nudicaulis, L. Wild Sarsaparilla.
Common throughout the state.

A. quinquefolia, Decaisne & Planch. Ginseng.
Throughout the state, excepting perhaps northwestward; local, wanting in some districts, rare far northward; frequent, occasionally abundant, in the region of the upper Mississippi, and in Mille Lacs, Pine, Anoka, Hennepin and Brown counties. Large quantities of the aromatic, medicinal root of this plant, mostly dug by the Chippewa Indians, are bought every year in the north part of the state, the price being about a dollar per pound. It is mostly exported to China; and the annual exportation of this article from the United States, mainly from Pennsylvania, West Virginia, Ohio, Michigan, Wisconsin and Minnesota, amounts to about $700,000. *U. S. Agricultural Report for* 1877, p. 545.

A. trifolia, Decaisne & Planch. Dwarf Ginseng. Ground-nut.
East part of the state, extending north to Pine county, *Clark;* lake Pepin, *Miss Manning;* Nicollet county, *Leiberg*.

CORNACEÆ. Dogwood Family.

CORNUS, Tourn. Cornel. Dogwood.

C. Canadensis, L. Dwarf Cornel. Bunch-berry.

Abundant through the north part of the state; extending south to Fergus Falls, *Leonard*, Wadena county, *Upham*, Minneapolis, *Winchell*, *Roberts*, and Saint Paul (rare), *Miss Cathcart*; rare and local farther southeast, as in Wabasha county, *Holzinger*, *Miss Manning*.

C. circinata, L'Her. Round-leaved Dogwood.

Frequent, occasionally common, throughout the state.

C. sericea, L. Silky Cornel. Kinnikinnick.

Frequent throughout the state, excepting far northward. The inner bark of this and the next following species, the leaves of the bearberry (Arctostaphylos Uva-ursi), and leaves of sumach, gathered when they turn red, are each used by the Indians, under the name *Kinnikinnick*, to mix with their tobacco for smoking. *Parry* states that the bark of this species, wherever it is found, is preferred for this purpose; and that the bark of the next is commonly substituted for it by the Indians about lake Superior.

C. stolonifera, Michx. Red-osier Dogwood. Kinnikinnick.

Abundant through the north half of the state, and common southward to Winona and Mower counties, *Winchell*, and Blue Earth county, *Upham*; but scarcely reaching into Iowa (in Emmet county, rare, *Cratty*). The name of the Redwood river, which is a translation of its original Indian name, is said by Prof. A. W. Williamson to be probably derived from this or the preceding species of Kinnikinnick.

C. asperifolia, Michx. Rough-leaved Dogwood.

Blue Earth river, *Parry*, *Leiberg*; Cannon River Falls, *Blake*, *Sandberg*; Hesper, Iowa (common), *Mrs. Carter*. South.

C. paniculata, L'Her. Panicled Cornel.

Common through the south half of the state, and in the Red river valley; the most plentiful species of cornel in the Big Woods; extending north to Todd and Wadena counties (common), *Upham*, but not reported in the region of the upper Mississippi river and northeastward.

C. alternifolia, L. Alternate-leaved Cornel.

Frequent, occasionally common, throughout the state, excepting far northward, where it is rare (at Poplar river, north of lake Superior, *Junt*).

CAPRIFOLIACEÆ.* Honeysuckle Family.

LINNÆA, Gronov. Linnæa. Twin-flower.

L. borealis, Gronov. Linnæa. Twin-flower.

Abundant north of lake Superior and thence to the sources of the Mississippi and northward; St. Louis river (usually having five perfect stamens), *Mrs. Herrick*; extending southwest to Wadena and Todd counties, *Upham*, and south to Minneapolis (at lake Calhoun), *Roberts*. In the northeast part of the state, "this pretty little plant, the

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*Advance sheets of a new part of Professor Gray's *Synoptical Flora of North America* (Vol. I, Part II; Caprifoliaceæ to Compositæ, inclusive), kindly sent by him while this catalogue was in process of being printed, have supplied very important corrections, especially in synonymy, as well as numerous additions, and valuable aid in the statements of geographic range.

Dwarf Cornel and the Clintonia are the most common small flowering plants found in the moss-carpeted forest." *Roberts*.

SYMPHORICARPOS, Dill. SNOWBERRY.

S. occidentalis, Hook. Wolfberry.

Common, often abundant, through the south half of the state; and northwesterly from Wadena county to the Red river valley, *Upham*, and the lake of the Woods, *Dawson*; infrequent northeastward. [North of lake Superior, *Agassiz*.]

S. racemosus, Michx. Snowberry.

Lake Pepin, *Miss Manning*; sources of the Mississippi, *Houghton*, *Garrison*; Red river valley, *Scott*. North.

S. racemosus, Michx., var. **pauciflorus**, Robbins. Snowberry.

Lake Pepin, *Miss Manning*; Minneapolis, *Winchell*; Stillwater, *Miss Field*; Redwood Falls, *Pemberton*; Isanti, Crow Wing and Wadena counties, *Upham*. North.

S. vulgaris, Michx. Indian Currant. Coral-berry.

Lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg*; Hennepin county, *Herrick*; upper Mississippi river, *Garrison*. Rare. South.

LONICERA, L. HONEYSUCKLE. WOODBINE.

[L. grata, Ait., has been several times reported in this state; but Gray's *Synoptical Flora of N. A.* shows that these references doubtless belong to some other species.]

L. Sullivantii, Gray. (L. flava, in part, Gray's *Manual*.) Yellow Honeysuckle.

Winona county, *Holzinger*; Lake City, *Miss Manning*; Cannon River Falls, *Blake*, *Sandberg*; Hennepin county, *Winchell*; Fergus Falls, *Leonard*.

L. glauca, Hill. (L. parviflora, Lam., and var. Douglasii, Gray, in *Manual*.) Yellow Honeysuckle. Crimson Honeysuckle.

Common, or frequent, throughout the state. This species with "crimson or deep dull purple" flowers has been noted by many observers in all parts of the state as a distinct variety, but Gray's *Synoptical Flora of N. A.* does not separate it from the type with greenish yellow flowers.

L. hirsuta, Eaton. Hairy Honeysuckle.

Lake Superior to the source of the Mississippi, *Houghton*; common north of lake Superior, *Juni*; Carlton county, *Roberts*; Pembina, *Chickering*, *Havard*. North.

L. involucrata, Banks. Involucrate Honeysuckle.

Isle Royale, lake Superior; doubtless also in northern Minnesota.

L. ciliata, Muhl. Fly-Honeysuckle.

North of lake Superior, *Juni*; Hennepin county, *Winchell*; frequent at Hesper, Iowa, *Mrs. Carter*.

L. cærulea, L. Mountain Fly Honeysuckle.

North shore of lake Superior (swamp near Port Arthur), *Macoun*; doubtless in northeastern Minnesota.

L. oblongifolia, Hook. Swamp Fly-Honeysuckle.

Kanabec county, *Upham*. North.

DIERVILLA, Tourn. BUSH-HONEYSUCKLE.

D. trifida, Mœnch. Bush-Honeysuckle.

Throughout the state; common, often abundant, northward, and frequent southward.

TRIOSTEUM, L. Fever-wort. Horse-Gentian.

T. perfoliatum, L. Fever-wort. Horse-Gentian.

Frequent through the south part of the state; extending north to Stearns and Todd counties, *Upham*.

ADOXA, L. MOSCHATEL.

A. Moschatellina, L.* Moschatel. Hollow-root. Musk Crowfoot.

Beside Rolling Stone creek, three miles west of Minnesota City, Winona county, *Holzinger;* Vasa, Goodhue county, *Sandberg*. Rare. (Also found at Decorah, Iowa, and on the Rocky mountains in Colorado; common far north in British America.)

SAMBUCUS, Tourn. ELDER.

S. Canadensis, L. Common Elder. Sweet Elder.

Common, or frequent, through the south half of the state, and rare northwesterly to Otter Tail and Becker counties.

S. racemosa, L. (S. pubens, Michx.) Red-berried Elder.

Common, or frequent, throughout the state.

VIBURNUM, L. ARROW-WOOD. LAURESTINUS.

V. Lentago, L. Sweet Viburnum. Sheep-berry. Black Haw.

Common through the south half of the state; extending north at least to Cass county (Fish-hook lake) and the White Earth reservation, *Garrison*, and to Pembina, *Chickering*, *Scott*, *Havard*.

V. cassinoides, L. (V. nudum, L., var. cassinoides, Torr. & Gray.) Withe-rod.

Upper Mississippi river and White Earth reservation, *Garrison*.

V. dentatum, L. Arrow-wood.

White Earth reservation, *Garrison;* Fergus Falls, *Leonard;* Minnesota river, *Parry;* Pipestone county, *Mrs. Bennett;* New Ulm (common), *Juni;* Minneapolis, *Griswold*, *Kassube;* lake Pepin, *Miss Manning*.

V. pubescens, Pursh. Downy Arrow-wood.

Common, or frequent, throughout the state.

V. acerifolium, L. Maple-leaved Arrow-wood. Dockmackie.

White Earth reservation, *Garrison;* Lake City, *Mrs. Ray*. Infrequent. Southeast.

[V. pauciflorum, Pylaie, will doubtless be found in northern Minnesota; and perhaps also V. lantanoides, Michx.]

V. Opulus, L. Cranberry-tree. Bush or High Cranberry.

Common through the north half of the state and in the Big Woods; frequent thence southeastward; absent far southwest. Fruit much used for sauce. The name Pembina, borne first by a river, and thence given to a town and county, is stated by Keating to be from the Chippewa word for this fruit, "*anepeminan*, which name has been shortened and corrupted into Pembina (Viburnum Oxycoccos)." *Narrative of Long's Expedition*, vol. ii, p. 38; see also p. 127.

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*ADOXA, L. A genus of but a single species, widely distributed throughout the cooler parts of the globe. Flowers perfect. Tube of the calyx coherent with the lower part of the ovary, the limb slightly 2—3 cleft. Petals 4—5, inserted on the limb of the calyx, united at the base, spreading. Stamens 4—5, each filament 2-parted; the divisions bearing each a single-celled peltate anther. Styles 4—5, subulate. Fruit an herbaceous and juicy berry, 4—5-celled; each cell with a single suspended seed. Seeds compressed, with a membranaceous margin.

A. MOSCHATELLINA, L. A small perennial herb, with the odor of musk; root tuberous; radical leaves twice ternately compound, on long petioles, the cauline solitary, 1—2 ternate or incised; flowers 4—6 (greenish) in a terminal capitulum, the lateral ones mostly pentamerous, the terminal tetramerous. *Torrey and Gray's Flora of N. A.*, as quoted by *Arthur*.

RUBIACEÆ. MADDER FAMILY.

GALIUM, L. BEDSTRAW. CLEAVERS.

G. Aparine, L. Cleavers. Goose-Grass.

Stearns county, *Mrs. Blaisdell;* Minneapolis, *Roberts;* Faribault, *Miss Beane;* Goodhue county, *Sandberg*; common at Hesper, Iowa, *Mrs. Carter*; frequent in Emmet county, Iowa, *Cratty*.

G. asprellum, Michx. Rough Bedstraw.

Common, or frequent, throughout the state.

G. concinnum, Torr. & Gray. Bedstraw.

Minneapolis, *Roberts;* Blue Earth county, *Leiberg;* Martin county (abundant), *Cratty;* Fergus Falls, *Leonard*. South.

G. trifidum, L. (G. tinctorium, L.) Small Bedstraw. Dyer's Cleavers.

Common, or frequent, throughout the state; exhibiting within our limits, the three varieties mentioned by Gray's *Manual*.

G. trifidum, L., var. **pusillum**, Gray. Small Bedstraw. Dyer's Cleavers.

Pembina, *Havard*. North.

G. trifidum, L., var. **latifolium**, Torr. Dyer's Cleavers.

Minneapolis, *Roberts*.

G. triflorum, Michx. Sweet-scented Bedstraw.

Throughout the state; common northward, frequent southward.

G. circæzans, Michx. Wild Licorice.

Lapham. Rare. Southeast.

G. lanceolatum, Torr. Wild Licorice.

Goodhue county, *Sandberg*. Rare. East.

G. boreale, L. Northern Bedstraw.

Abundant, or common, throughout the state.

CEPHALANTHUS, L. BUTTON-BUSH.

C. occidentalis, L. Button-bush.

Lapham. Taylor's Falls, *Roberts;* shore of lake Pepin in Wisconsin, *Miss Manning*. South.

MITCHELLA, L. PARTRIDGE-BERRY.

M. repens, L. Partridge-berry.

St. Croix river, *Parry, Miss Field;* upper Mississippi river, *Garrison;* northern Kanabec county (common), *Upham;* abundant at Taylor's Falls and Duluth, *Miss Cathcart*.

HOUSTONIA, Gronov. HOUSTONIA.

H. purpurea, L., var. **longifolia**, Gray. Houstonia.

Frequent throughout most of the state. Gooseberry river, lake Superior, *Juni;* St. Louis river, *Houghton*; lake of the Woods, *Dawson;* and thence south at least to

Chisago county (plentiful), *Upham*, lake Pepin, *Miss Manning*, Blue Earth county, *Leiberg*, and the Upper Minnesota river, *Parry*.

H. purpurea, L., var. **ciliolata**, Gray. Houstonia.

Stearns county, *Campbell*. [Walhalla, northeastern Dakota, *Scott*.]

VALERIANACEÆ. VALERIAN FAMILY.

VALERIANA, Tourn. VALERIAN.

V. edulis, Nutt. Valerian.

Upper Mississippi river, *Parry*; Minneapolis, *Roberts*; lake Pepin, *Miss Manning*; Faribault, *Miss Beane*; Winona county, *Holzinger*; Fillmore county, *Mrs. Carter*; Steele county (frequent), *Upham*.

[V. sylvatica, Banks, probably also occurs northward.]

VALERIANELLA, Tourn. (FEDIA, Gærtn.) CORN SALAD. LAMB LETTUCE.

V. chenopodifolia, DC. (F. Fagopyrum, Torr. & Gray.) Corn Salad. Lamb Lettuce.

Lake Pepin, *Miss Manning*; eastern Rice county (common), *Upham*. Southeast.

V. radiata, Dufresne. (F. radiata, Michx.) Corn Salad. Lamb Lettuce.

Lapham. Cannon River Falls, *Blake, Sandberg*. Rare. Southeast.

DIPSACEÆ. TEASEL FAMILY.

DIPSACUS, Tourn. Teasel.

D. sylvestris, Mill. *Wild Teasel.*

Lake Pepin, *Miss Manning*. Infrequent.

COMPOSITÆ. COMPOSITE FAMILY.

VERNONIA, Schreb. IRON-WEED.

V. Noveboracensis, Willd. Iron-weed.

Upper Mississippi river, *Houghton*; Hennepin county, *Herrick*; St. Paul, *Kelley*; Blue Earth county, *Leiberg*. Southeast.

V. fasciculata, Michx. Iron-weed.

Common through the south half of the state and in the Red river valley, *Upham*.

LIATRIS, Schreb. BUTTON SNAKEROOT. BLAZING-STAR. GAY FEATHER.

L. squarrosa, Willd. Blazing-Star.

Common through the south part of the state; extending north to the upper Mississippi river, *Garrison*.

[L. squarrosa, Willd., var. intermedia. DC. (heads narrow; bracts of the involucre erect or little spreading, less prolonged), probably also occurs in this state, according to Gray's *Synoptical Flora of N. A.*]

L. cylindracea, Michx. Button Snakeroot. Blazing-Star.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river, *Houghton*, *Garrison*, and Fergus Falls, *Leonard*.

L. scariosa, Willd. Blazing-Star. Gay Feather.

Common, often abundant, through the south half of the state, being the most plentiful species southwestward; also common in the Red river valley, especially north of Sand Hill river and along the old Pembina trail, *Upham*; extending northeast to the upper Mississippi river, *Houghton*. (A remarkable form of this species, bearing the heads at the end of leafy, ascending branches, 2 to 6 inches long, was found in a bog near Mankato by *Mr. Leiberg*. White-flowered specimens have been collected by *Mr. W. H. Kelley*, at Dellwood, White Bear lake, Ramsey county.)

L. spicata, Willd. Blazing-Star.

Lake Pepin, *Miss Manning*; Minneapolis, *Kassube*; Anoka county, also New Ulm, *Juni*; Blue Earth county, *Leiberg*, *Gedge*; Kandiyohi county, *Upham*; Fergus Falls, *Leonard*. Less frequent than the last and the next. South.

L. pycnostachya, Michx. Blazing-Star.

Common through the south half of the state; very abundant in the Red river valley in Clay and Norman counties, but rare or infrequent north of Sand Hill river, *Upham*. This species is three weeks earlier in flowering than L. scariosa, and prefers moister ground.

L. punctata, Hook.* Blazing-Star.

Generally common on the drier portions of the prairie, in the west part of the state, extending east to Martin county, *Cratty*, Saint Peter, *Gedge*, and the St. Croix river, *Swezey*; but infrequent north of the Sand Hill river; seen in Kittson county only at the Ridge, twelve miles east of Saint Vincent, *Upham*, *Dawson*; also found at Pembina, *Havard*.

KUHNIA, L. Kuhnia.

K. eupatorioides, L. Kuhnia.

Frequent, or common, through the south part of the state; Goodhue county, *Sandberg*; Hennepin county, *Herrick*; Blue Earth county, *Leiberg*; common southwestward (leaves broadly lanceolate, deeply toothed), *Upham*; extending northwest to Devil's lake, Dakota, *Geyer*.

K. eupatorioides, L., var. **corymbulosa,** Torr. & Gray.† Kuhnia.

Prairies and plains, Illinois to Dakota and Nebraska, and south to Alabama and Texas, *Gray's Synoptical Flora of N. A.*; therefore doubtless in southern and western Minnesota.

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* LIATRIS PUNCTATA, Hook. Stems 8 inches to 3 feet high, from a thick, knotted, fusiform root, glabrate, leafy to the top; leaves linear, rigid, strongly punctate on both sides, glabrous or their margins somewhat ciliate, lower ones 3 to 5 inches long, slightly 3-nerved, 1 to 3 lines wide, pungently acute; heads in a dense spike, 4 to 10 inches long, 4- to 6-flowered; flowers reddish-purple; scales of the cylindraceous involucre oblong, strongly punctate, imbricated, appressed, with mucronate, acuminate, rather spreading tips, margins woolly-ciliate; bristles of the pappus about 30, purplish or white, very plumose; achenia hairy. *Porter and Coulter's Flora of Colorado.*

†KUHNIA EUPATORIOIDES, L., var. CORYMBULOSA, Torr. & Gray. A foot or two high, stouter, somewhat cinereous-pubescent or tomentulose: leaves rather rigid and sessile, from oblong to lanceolate, coarsely veiny: heads rather crowded. *Gray's Synoptical Flora of N. A.*

EUPATORIUM, Tourn. THOROUGHWORT. BONESET.

E. purpureum, L. Joe-Pye Weed. Trumpet-weed.

Common throughout the state.

E. purpureum, L., var. **maculatum,** Darl.* Joe-Pye Weed. Trumpet-weed.

Frequent, or common, throughout the state.

E. altissimum, L. Tall Boneset.

Lapham. Goodhue county, *Sandberg*; Blue Earth county, *Leiberg*, *Gedge*. Rare. South.

E. perfoliatum, L. Thoroughwort. Boneset.

Common, or frequent, through the south half of the state; upper Mississippi river, *Garrison*; less frequent farther north to the lake of the Woods, *Dawson*. Well known as a bitter tonic.

E. serotinum, Michx. Thoroughwort. Boneset.

Lapham. Todd county (frequent), *Upham;* Martin county, and Emmet county, Iowa (common), *Cratty*. South.

E. ageratoides, L. f. White Snake-root.

Common, or frequent, throughout the state.

PETASITES, Tourn. (NARDOSMIA, Cass.) SWEET COLTSFOOT.

P. sagittata, Gray.† (N. sagittata, Hook.) Sweet Coltsfoot.

Red river valley near Saint Vincent (in a "low damp thicket; in full bloom in the first week of May; seed nearly ripe, June 4; flower with an odor like that of Cratægus, white, tinged with purple"), *Dawson;* also on Roseau river, *Scott*. Rare. Northwest.

[P. palmata, Gray, (N. palmata, Hook.) probably also occurs in Minnesota.]

TUSSILAGO, Tourn. COLTSFOOT.

T. Farfara, L. *Coltsfoot. "Ginger-root."*

Northeastward, "much used as a cough medicine," *Clark*; lake Pepin, *Miss Manning*.

ADENOCAULON, Hook. ADENOCAULON.

A. bicolor, Hook. Adenocaulon.

Stearns county, *Garrison*. Rare. North.

ASTER, Tourn. STARWORT. ASTER.

A. corymbosus, Ait. Aster.

Hennepin county, *Roberts*. [North of lake Superior, *Agassiz*.] Infrequent.

A. macrophyllus, L. Large-leaved Aster.

Abundant north of lake Superior, *Roberts;* lake of the Woods, *Dawson*; upper

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* EUPATORIUM PURPUREUM, L., var. MACULATUM, Darl. Common in open ground, 3 or 4 feet high, often roughish-pubescent: stem commonly purple, striate or sulcate; leaves somewhat rugose, 3—5-nate: inflorescence more compact and depressed. . . . . . The most widely distributed form. *Gray's Synoptical Flora of N. A.*

† PETASITES SAGITTATA, Gray. Leaves from deltoid-oblong to reniform-hastate, from acute to rounded-obtuse, repand-dentate, very white-tomentose beneath, when full grown 7 to 10 inches long: heads short-racemose, becoming corymbose: ligules equalling or shorter than the disk. *Gray's Synoptical Flora of N. A.*

Mississippi river, *Garrison*; Todd and Crow Wing counties (common), *Upham;* White Bear, Ramsey county, *Simmons*. North and east.

A. sericeus, Vent. Silky Aster.

Common through the south half of the state, and frequent in the Red river valley, *Upham*; extending northeast to the upper Mississippi river, *Garrison*, and the mouth of Rainy river, *Macoun*.

A. patens, Ait. Aster.

Upper Mississippi river, *Garrison;* Fergus Falls, *Leonard;* Douglas county, *Mrs. Terry;* Anoka county, *Juni;* Blue Earth county, *Gedge*. Infrequent. South.

A. lævis, L. Smooth Aster.

Frequent, or common, in both var. lævigatus and var. cyaneus, of Gray's *Manual*, through the south half of the state and in the Red river valley; extending northeast to Crow Wing county, *Upham*.

A. azureus, Lindl. Azure Aster.

Prairies of the Blue Earth river, *Geyer;* Goodhue county, *Sandberg;* Minneapolis, *Twining*, *Roberts;* Douglas county, *Mrs. Terry*. South.

A. Shortii, Boott. Short's Aster.

Lapham. Rare. Southeast.

A. undulatus, L. Wavy Aster.

Lapham. Douglas county, *Mrs. Terry;* Blue Earth county, *Gedge*. Infrequent. South.

A. cordifolius, L. Heart-leaved Aster.

Common in woods through the south half of the state, and in the Red river valley; only reported northeastward by *Juni* at Little Marais, lake Superior.

A. sagittifolius, Willd. Arrow-leaved Aster.

North of lake Superior (abundant), *Roberts*, *Juni;* Douglas county, *Mrs. Terry;* falls of the St. Croix, *Parry;* Minneapolis, *Roberts;* lake Pepin, *Miss Manning;* Minnesota river, *Geyer;* Emmet county, Iowa (common), *Cratty;* and westward into Dakota, *Gray's Synoptical Flora of N. A.*

A. Drummondii, Lindl.* Drummond's Aster.

Open grounds and border of woods, Illinois and Minnesota to Texas. Forms pass into A. sagittifolius. *Gray's Synoptical Flora of N. A.*

A. ericoides, L, var. **villosus,** Torr. & Gray. Heath-like Aster.

Blue Earth county, *Gedge*. South.

A. multiflorus, Ait. Many-flowered Aster.

Common, often abundant, through the south half of the state and in the Red river valley; extending northeast to Todd and Crow Wing counties (common), *Upham*.

A. dumosus, L. Aster.

Lake Pepin, *Miss Manning;* Blue Earth county, *Gedge*. Infrequent. Southeast.

A. vimineus, Lam. (A. Tradescanti, in Gray's *Manual*.) Aster.

Lake Pepin, *Miss Manning;* Douglas county, *Mrs. Terry;* common southward and westward, *Juni*, *Upham*.

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*ASTER DRUMMONDII, Lindl. Pale with a fine and mostly soft cinereous pubescence; leaves from cordate to cordate-lanceolate and mostly on margined petioles, or the small uppermost lanceolate and sessile by a narrow base, obtusely or acutely serrate (the large 4 inches, smaller about an inch long), sometimes scabrous above: bracts of the involucre acute or acutish; rays violet-blue or paler, 3 to 5 lines long. *Gray's Synoptical Flora of N. A.*

A. Tradescanti, L.* Tradescant's Aster.

Open grounds, Canada to Virginia, Illinois and Saskatchewan. Nearly allied with the two preceding and the two following species. *Gray's Synoptical Flora of N. A.*

A. diffusus, Ait. (A. miser, in *Manual.*) Aster.

Throughout the state. Common north of lake Superior, and at Minneapolis, *Roberts;* lake of the Woods, *Dawson;* Todd county, *Upham;* St. Croix river, *Parry;* Goodhue county, *Sandberg;* Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty.*

A. paniculatus, Lam. (A. simplex, and A. tenuifolius, partly, in *Manual.*) Panicled Aster.

Common, or frequent, throughout the state; especially plentiful westward.

A. polyphyllus, Willd.† (A. tenuifolius, partly, in *Manual.*) Aster.

Notes of A. tenuifolius, as described in Gray's *Manual,* probably belonging in part to A. polyphyllus, are as follows: upper Mississippi river, *Houghton;* Fergus Falls, *Leonard;* Douglas county, *Mrs. Terry;* Wadena and Todd counties, *Upham;* Blue Earth county, *Leiberg;* Emmet county, Iowa (rare), *Cratty.*

A. salicifolius, Ait. (A. carneus, in *Manual.*) Aster.

Douglas county, *Mrs. Terry;* Lac qui Parle, *Upham;* Anoka county, *Juni.* [Also northwest to the Saskatchewan river and eastern Montana, *Gray's Synoptical Flora of N. A.*]

A. junceus, Ait. (A. æstivus, in *Manual.*) Aster.

Throughout the state, but infrequent. Blue Earth county, *Leiberg;* Goodhue county, *Sandberg;* Anoka county, *Juni;* Douglas county, *Mrs. Terry;* Pembina, *Havard.* [North of lake Superior, *Agassiz.*]

A. longifolius, Lam.‡ Long-leaved Aster.

This species (not the one so named in Gray's *Manual,* which is the next; more nearly related with A. junceus) doubtless occurs in northern Minnesota.

A. Novi-Belgii, L. (Including A. longifolius of Gray's *Manual.*) New York Aster.

Spirit lake, Iowa, *Geyer;* Blue Earth county, *Gedge;* southwestward (frequent), *Juni;* Douglas county, *Mrs. Terry;* Fergus Falls, *Leonard;* upper Mississippi river, *Garrison;* Pembina, *Havard.*

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[*] ASTER TRADESCANTI, L. Stem slender, 2 to 4 feet high, with numerous erect or ascending branches and branchlets: leaves lanceolate or linear, slightly serrate or entire, thinnish: small heads numerous, corymbosely or somewhat racemosely paniculate [the most notable distinction from A. vimineus]; only two or three lines high: bracts of the involucre linear, acutish, partly green at tip and down the back: rays white, or sometimes tinged with lilac, only about 2 lines long. *Gray's Synoptical Flora of N. A.*

[†] ASTER POLYPHYLLUS, Willd. Mostly tall (4 or 5 feet high), with virgate branches, glabrous: cauline leaves narrowly lanceolate or linear (4 or 5 inches long, quarter to half inch wide); those of flowering branchlets small and subulate-linear: heads paniculate (4 lines high): involucre nearly hemispherical; involucral bracts lanceolate-subulate, outer successively shorter, rather rigid, with green nearly erect tips; rays numerous, bright white, disposed to turn rose-purplish, 4 lines long: akenes minutely pubescent. *Gray's Synoptical Flora of N. A.*

[‡] ASTER LONGIFOLIUS, Lam. A foot to a yard high, glabrous or pubescent, leafy: leaves elongated-lanceolate to linear-lanceolate, entire or sparingly serrulate, 3 to 7 inches long, tapering to both ends: involucre 4 to 5 lines high, little or not at all imbricated; its bracts all of nearly equal length, some looser, outermost not rarely quite herbaceous: rays 3 or 4 lines long, violet or purplish, rarely almost white. . . . . Low grounds or along streams, Labrador to Montana, Slave Lake, south to Canada and N. New England. *Gray's Synoptical Flora of N. A.*

A. puniceus, L. Aster.

Common throughout the state, excepting northwestward; extending to Fergus Falls, *Leonard*, and into Dakota, *Gray's Synoptical Flora*; but not observed in the Red river valley, *Upham*.

A. puniceus, L., var. **lucidulus**, Gray. (var. vimineus, Torr. & Gray.) Aster.

Frequent in the south half of the state.

A. prenanthoides, Muhl. Aster.

Lapham. Common in the vicinity of Hesper, Iowa, adjoining Houston and Fillmore counties, *Mrs. Carter*. Southeast.

A. oblongifolius, Nutt. Aster.

Douglas county, *Mrs. Terry*; Fort Snelling, *Roberts*; Minneopa falls, Blue Earth county, *Upham*; Pipestone county, *Mrs. Bennett*. South.

[A. amethystinus, Nutt., occurs in Iowa, and probably also in Minnesota, *Arthur*.]

A. Novæ-Angliæ, L. New England Aster.

Minneapolis, *Twining*, *Roberts*; lake Pepin, *Miss Manning*; common at Hesper, Iowa, *Mrs. Carter*; Blue Earth county, *Gedge*; Rock county, *Leiberg*. [Upper Missouri river, *Geyer*, and Saskatchewan, *Gray's Synoptical Flora of N. A.*] South and west.

A. modestus, Lindl.* Aster.

Moist woods, Oregon to British Columbia on the Pacific, and east to Saskatchewan and Pembina (*Macoun*), *Gray's Synoptical Flora of N. A.* Northwest.

[A. GRAMINIFOLIUS, Pursh., is ERIGERON HYSSOPIFOLIUS, Michx., in *Gray's Synoptical Flora of N. A.*, and will be found accordingly under that genus.]

[A. acuminatus, Michx., should be looked for in northern Minnesota.]

A. ptarmicoides, Torr. and Gray. Aster.

Abundant, or common, throughout the state. [The var. lutescens, Gray, with "rays pale yellow, small," which occurs in Manitoba and northern Illinois (*Gray's Synoptical Flora of N. A.*), will probably be found also in Minnesota.]

A. angustus, Torr. and Gray. Aster.

Lapham. Clay county, in the Red river valley, *Gedge*, determined by *Watson*. Northwest.

A. linariifolius, L. (Diplopappus linariifolius, Hook.) Double-bristled Aster.

Lapham. Rare. East.

A. umbellatus, Mill. (Diplopappus umbellatus, Torr. & Gray.) Double-bristled Aster.

Throughout the state: abundant northward, common or frequent southward.

A. umbellatus, Mill., var. **pubens**, Gray. Double-bristled Aster.

Lower face of the oblong-lanceolate leaves tomentulose-pubescent, also usually the flowering branchlets.—Saskatchewan to upper Michigan. *Gray's Synoptical Flora of N. A.*

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* ASTER MODESTUS, Lindl. Merely pubescent or glabrate: stem more slender than in the two preceding species, 2 feet high: leaves thinnish, lanceolate or broader (2 to 4 inches long), sparingly and acutely serrate or denticulate, very acute, mostly narrowed to a sessile or partly clasping but not auriculate base: heads fewer and smaller than in the preceding, hemispherical, numerous and usually thyrsoidly or cymosely congested at the summit of the simple very leafy stem: bracts of the involucre less numerous, loose, and more or less herbaceous (or somewhat colored) almost from the base, linear-attenuate, all equalling the disk: rays numerous and narrow, pale blue: style-appendages lanceolate: akenes hirsute. *Gray's Synoptical Flora of N. A.*

ERIGERON, L. FLEABANE.

E. hyssopifolius, Michx. (Aster graminifolius, Pursh.) Fleabane.

North shore of lake Superior, *Juni*; between the lake of the Woods and Red river, *Dawson*. North.

E. Canadensis, L. Horse-weed. Butter-weed.

Common throughout the state.

E. divaricatus, Michx. Dwarf Fleabane.

Open grounds and river banks, Indiana to Minnesota, Nebraska and Texas. *Gray's Synoptical Flora of N. A.*

E. acris, L. Fleabane.

North shore of lake Superior, *Macoun*; doubtless in northern Minnesota. [Perhaps the var. DRŒBACHENSIS, Blytt, which has a similar range with the typical species. Somewhat glabrous, or even quite so: involucre also green, naked, at most hirsute only at the base, often minutely viscidulous: slender rays somewhat slightly exserted, sometimes minute and filiform and shorter than the pappus. . . . . North shore of lake Superior, etc. *Gray's Synoptical Flora of N. A.*]

E. bellidifolius, Muhl. Robin's Plantain.

Frequent southward; extending north at least to Isanti county, *Upham*, and Clay county and Detroit, Becker county, *Gedge*.

E. Philadelphicus, L. Common Fleabane.

Frequent, occasionally common, throughout the state.

E. glabellus, Nutt. Fleabane.

Goodhue county, *Sandberg*; Red river valley near Saint Vincent, *Dawson, Scott*. [Devil's lake, Dakota, *Geyer*.] West.

E. annuus, Pers. Daisy Fleabane. Sweet Scabious.

St. Croix Falls, *Miss Field*; Minneapolis, *Miss Butler*; lake Pepin, *Miss Manning*; frequent in the vicinity of Hesper, Iowa, adjoining the southern boundary of Houston and Fillmore counties, *Mrs. Carter*. This species reaches its northwest limit in southeastern Minnesota; it was not observed, though carefully looked for, throughout the remainder of the state.

E. strigosus, Muhl. Daisy Fleabane.

Throughout the state; common southward, infrequent northward.

[The species referred to the genus DIPLOPAPPUS, Cass., in Gray's *Manual*, are included under ASTER in his *Synoptical Flora of N. A.*; and in this catalogue they are placed at the end of that genus.]

BOLTONIA, L'Her. BOLTONIA.

B. asteroides, L'Her. (Including B. glastifolia, L'Her.) Boltonia.

Common through the south part of the state; extending north at least to Minneapolis, *Williams*, Alexandria, *Mrs. Terry*, Fergus Falls, *Leonard*, and Devil's lake, Dakota, *Geyer*. South and west.

GUTIERREZIA, Lagasca. GUTIERREZIA.

G. Euthamiæ, Torr. & Gray.* Gutierrezia.

Red river valley near Saint Vincent, *Scott*, determined by *Watson*. West.

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* GUTIERREZIA, Lagasca. Heads small or middle-sized, 6- to 90-flowered, the rays pistillate, fertile, the disk-flowers tubular, perfect and fertile. Involucre varying from narrowly obconic to broadly hemispherical, the scales closely imbricated in several series, rigid, and with greenish herbaceous tips. Receptacle naked. Corollas yellow,

SOLIDAGO, L. GOLDEN-ROD.

S. bicolor, L. Golden-rod.

Lapham. The typical species is rare.

S. bicolor, L., var. **concolor,** Gray. Golden-rod.

Common on rocks, north shore of lake Superior, *Roberts, Juni*; northwest side of Mille Lacs, *Upham*; falls of the St. Croix, *Parry.*

S. latifolia, L. Golden-rod.

Common, or frequent, throughout the state.

S. cæsia, L. Golden-rod.

Lake Minnetonka, *Roberts, Herrick*; lake Pepin, *Miss Manning.* Infrequent. Southeast.

S. puberula, Nutt. Golden-rod.

Lapham. Le Sueur county, *Gedge*; Pembina, *Havard.* A golden-rod agreeing well, except as to geographical limits, with the description of this species in Gray's *Manual*, is common on dry prairies throughout southern Minnesota, extending northeast to Todd and Crow Wing counties, *Upham.*

S. uliginosa, Nutt. (S. stricta, in Gray's *Manual.*) Golden-rod.

North of lake Superior (common), *Roberts*; Anoka county, *Juni*; St. Croix river, *Parry*; lake Pepin, *Miss Manning.* North.

S. speciosa, Nutt. Golden-rod.

Minneapolis, *Roberts;* lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg.* South.

S. speciosa, Nutt., var. **angustata,** Torr. & Gray. Golden-rod.

Stearns county, *Campbell*; Emmet county, Iowa (rare), *Cratty.*

S. speciosa, Nutt., var. **rigidiuscula,** Torr. & Gray. Golden-rod.

A form of the var. angustata, growing in dry open places, with more rigid and rougher-edged small leaves. Minnesota to Nebraska and Texas. *Gray's Synoptical Flora of N. A.*

S. Virgaurea, L., var. **alpina,** Bigelow. Golden-rod.

Lapham. North.

[S. humilis, Pursh (S. Virgaurea, L., var. humilis, Gray), and S. macrophylla, Pursh (S. thyrsoidea, E. Meyer), probably also occur, with the preceding, in northeastern Minnesota.]

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of the ray oval, oblong or linear, of the disk funnel-shaped, 5-toothed, the teeth erect or recurved. Branches of the style in the ray-flower, linear, smooth, the stigmatic lines extending to the top; in the disk, with the hairy appendages shorter or several times longer than the stigmatic portion. Achenia oblong or obconic, terete or somewhat compressed. Pappus of the disk composed of several oblong or linear chaffy scales, or reduced to a lacerate coroniform border, of the ray similar to that of the disk, but commonly smaller or sometimes obsolete.—Mostly perennial and suffruticose plants of North and South America, with glabrous and often resinous-dotted or varnished linear and entire or broader and denticulate leaves.

G. EUTHAMIÆ, Torr. and Gray. Stems 6 to 15 inches high, numerous from a woody and much-branched base, striated; leaves crowded, narrowly linear, 1 to 2 inches long ½ to 1 line wide, 1-nerved, minutely scabrous, punctate, resinous, and sometimes varnished; heads in little clusters forming compound corymbs; involucres scarcely 2 lines long and 1 line broad, narrowly obovate; flowers of the ray 2 to 5, of the disk 3 to 6; pappus of 9 or 10 obtuse unequal erose-denticulate chaffy scales, a little shorter than the achenium.—Plant growing in dense tufts, when in flower forming a conspicuous yellow round-topped bushy clump. *Eaton* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

S. rigida, L. Golden-rod.

Abundant through the south half of the state, and in the Red river valley, extending northeast to Crow Wing county, *Upham*. Usually from one and a half to two feet high on prairies, where it most abounds; but from three to five feet high in woods and thickets.

S. Riddellii, Frank. Riddell's Golden-rod.

Minneapolis, *Williams*; Rapidan Rapids, Blue Earth county, *Upham*; peat bogs, Blue Earth county, *Leiberg*; common in Emmet county, Iowa, *Cratty*. South.

S. neglecta, Torr. & Gray. Golden-rod.

Lapham. Infrequent. Southeast.

S. patula, Muhl. Golden-rod.

Lapham. Infrequent. Southeast.

S. juncea, Ait. (S. arguta, var. juncea, Gray, in *Manual*.) Golden-rod.

Common, or frequent, throughout the state, excepting perhaps near its south side; flowering early.

S. juncea, Ait., var. **scabrella**, Gray. (S. arguta, var. scabrella, Torr. & Gray, in *Manual*.) Golden-rod.

Rice county, *Upham*. Probably infrequent. Southeast.

S. arguta, Ait. (S. Muhlenbergii, Torr. & Gray.) Golden-rod.

North of lake Superior, *Juni*. Rare. East.

S. rugosa, Mill. (S. altissima, in *Manual*.) Golden-rod.

Blue Earth county, *Gedge*. Infrequent.

S. ulmifolia, Muhl. Golden-rod.

Lapham. Falls of the St. Croix, *Parry*. Infrequent. Southeast.

S. nemoralis, Ait. Golden-rod.

Common, often abundant, throughout the state.

S. nemoralis, Ait., var. **incana**, Gray.* Golden-rod.

Plains of Minnesota and Dakota (*Nicollet*, etc.) to the Rocky Mountains of Montana and Colorado. *Gray's Synoptical Flora of N. A.*

S. radula, Nutt. Golden-rod.

Blue Earth county, *Leiberg*; Stearns county, *Campbell*; Yellow Medicine county (frequent), *Upham*. South.

S. Missouriensis, Nutt. Golden-rod.

Saint Paul, *Kelley*; Minneapolis, *Twining*, *Roberts*, *Simmons*; Martin county, and Emmet county, Iowa (abundant), *Cratty*; high prairies towards the sources of the Minnesota river, *Geyer*; Red river valley, *Scott*. South and west.

S. Canadensis, L. Golden-rod.

Common throughout the state. [The var. procera, Torr. & Gray, probably also occurs in Minnesota, especially northwestward.]

S. serotina, Ait., var. **gigantea**, Gray. (S. serotina, in *Manual*.) Golden-rod.

Common, or frequent, throughout the state.

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*SOLIDAGO NEMORALIS, Ait., var. INCANA, Gray. Dwarf, a span to a foot high: leaves oval or oblong, rigid, more or less canescent, sometimes rather strongly serrate, sometimes mostly entire: racemiform clusters erect or the lower somewhat spreading, collected in a dense oblong or conical thyrsus. *Gray's Synoptical Flora of N. A.*

S. serotina, Ait. (S. gigantea, in *Manual.*) Golden-rod.

Common, or frequent, throughout the state, especially north of lake Superior, *Roberts*, and in the Red river valley, *Upham.*

S. lanceolata, L. Golden-rod.

Common throughout the state; abundant in the Red river valley.

S. occidentalis, Nutt.[*] Golden-rod.

Sandy soil, Saint Peter, Nicollet county, *Leiberg;* determined by *Watson* as "probably" this species. Infrequent. Southwest.

APLOPAPPUS, Cass. APLOPAPPUS.

A. spinulosus, DC.[†] Aplopappus.

Upper Minnesota river, *Geyer;* Yellow Medicine county, *Upham.* Southwest.

GRINDELIA, Willd. GRINDELIA.

G. squarrosa, Dunal.[‡] Grindelia.

Common, or frequent, in the west edge of the state, from Rock county, *Leiberg*, and Pipestone City to Saint Vincent, *Upham;* also plentiful on the quartzite ridge in northern Cottonwood county, *Upham.* West.

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[*] SOLIDAGO OCCIDENTALIS, Nutt. Smooth; stems 2 to 3 feet high, paniculately corymbose at the summit, leafy; leaves linear-lanceolate, obscurely 3- to 5-nerved, minutely scabrous on the edges, the larger ones 4 inches long, 3 lines broad; heads rather large, pedicellate in many small corymbs, broadly obconic; involucral scales loosely imbricated in about 3 series, oblong-linear, the straight tips greenish, ciliolate, rather acute; rays 15 to 25, very small; disk-flowers 10 to 15; achenia pubescent. *Eaton* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

[†] APLOPAPPUS, Cass. Heads solitary, terminating the branches, or sometimes corymbosely or spicately clustered, many-flowered, rarely several-flowered, heterogamous and with fertile rays, or very rarely homogamous, the rays being wanting. Involucre imbricated, the scales with or sometimes without herbaceous or foliaceous tips. Receptacle flat or flattish, foveolate or alveolate-dentate. Appendages of the style-branches triangular-lanceolate, or in the N. American species more commonly elongated subulate. Akenes varying from turbinate to linear, terete, angled, or more or less compressed. Pappus simple, of copious and unequal rigid capillary (scabrous or almost barbellate) bristles.—Herbs or low under-shrubby plants, of various aspect and foliage; with yellow flowers, and pappus varying from tawny to reddish, very rarely bright white. Leaves alternate, rigid. *Gray* in *Botany of California*, from *Proc. Am. Acad.*, vol viii.

A. SPINULOSUS, DC. Herbaceous, canescent with a soft, minute, woolly pubescence; stems many, 1 to 2 feet high, corymbosely branched above; leaves small, 9 to 12 lines long, rigid, pinnately or somewhat bi-pinnately parted, segments short, linear-subulate, mucronate with a short bristle; heads small, subglobose, terminating the numerous branchlets; involucre shorter than the disk, scales subulate-lanceolate, mucronulate, imbricated in 3 or 4 series, appressed, canescent; rays 20 to [illegible]; corolla of the disk with very short teeth; pappus pale or tawny, short, very unequal; achenia turbinate, villous. *Porter and Coulter's Flora of Colorado.*

[‡] GRINDELIA, Willd. Heads many-flowered; the ray-flowers generally present, pistillate, the ligule elongated; disk-flowers perfect, the corolla tubular-funnel-shaped, 5-toothed. Involucre subglobose or hemispherical, the scales imbricated in many rows, often with squarrose tips. Receptacle naked, flat, foveolate. Style with lanceolate hispid appendages as long as the stigmatic portion. Achenium smooth, oblong or ovate somewhat angled. Pappus of 2 to 8 smooth rigid deciduous awns, shorter than the disk-corollas.—Biennial (?), perennial or suffruticose, often resiniferous, Mexican and North American plants. Leaves entire or serrate, often punctate, the cauline ones sessile. Heads corymbed at the ends of the branches, or solitary, mostly rather large.

G. SQUARROSA, Dunal. Glabrous and viscidly resinous; stems herbaceous from a

CHRYSOPSIS, Nutt. GOLDEN ASTER.

C. villosa, Nutt. Golden Aster.

Common throughout most of the state; but probably wanting or infrequent near its south side, and also northeastward. Fort Snelling, *Parry;* Minneapolis (common), *Roberts;* upper Mississippi river, *Houghton, Garrison;* common in Stearns and Todd counties and in the Red river valley, *Upham.*

INULA, L. ELECAMPANE.

I. Helenium, L. *Elecampane.*

Nicollet county, *Aiton;* Minneapolis, *Roberts.* Infrequent.

POLYMNIA, L. LEAF-CUP.

P. Canadensis, L. Leaf-cup.

Lapham. Rare. South.

SILPHIUM, L. ROSIN-PLANT.

S. laciniatum, L. Rosin-weed. Compass-Plant.

Common, often abundant, in the south edge of the state; extending north to Goodhue county, *Sandberg*, southeastern Rice county (plentiful), Nicollet county, *Aiton*, southeastern Watonwan county (frequent), and New Ulm (very scarce), *Juni;* and west to Luverne, *Upham;* and into Dakota, Gray's *Synoptical Flora of N. A.* A gum which is frequently chewed like that of the spruce, exudes from stems of this plant, when their tops are broken off. The peculiar deflection of the leaves to a north and south direction, at the same time presenting one edge upward and the other toward the ground, is very noticeable. (See *American Naturalist*, vol. xvi, pp. 625—635, and vol. xvii, pp. 542 and 656.)

S. terebinthinaceum, Jacq. Prairie Dock. Rosin-Plant.

Lapham. Blue Earth county, *Leiberg.* South.

S. integrifolium, Michx. Rosin-Plant

Lapham. South.

S. perfoliatum, L. Cup-Plant.

Common southward; extending north to Minneapolis, *Roberts*, the Minnesota river (common), Fergus Falls, *Leonard*, and the Sisseton Agency in Dakota, *Upham.*

PARTHENIUM, L. PARTHENIUM.

P. integrifolium, L. Parthenium.

Lapham. South.

IVA, L. MARSH ELDER. IVA.

I. xanthiifolia, Nutt. (Cyclachæna xanthiifolia, Fres.) Iva.

Frequent southeastward; abundant southwestward; extending north to Todd

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perennial caudex, 12 to 20 inches high, corymbosely branched above; leaves somewhat rigid, glaucous and punctate-reticulated; the radical ones spatulate-lanceolate, narrowed into a petiole, dentate or incised; the cauline mostly oblong, sessile and partly clasping, finely toothed or spinulose-serrate; heads [yellow] numerous; involucels sub-globose, 6 lines broad; the scales very rigid, closely appressed, but with very long reflexed or squarrose subulate points; rays numerous, rather narrow; pappus of 2 to 4 very rigid deciduous bristles or awns. August. *Eaton* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

county (common), and in the Red river valley to Grand Forks, *Upham*, and Saint Vincent, *Scott, Havard.* "A new weed that is steadily gaining ground, traveling eastward and possibly southward. It is a candidate for the same situations the large ragweed prefers—the edges of fields, and along roadsides and streets, but especially about barns. If circumstances are unfavorable, it can blossom when only a few inches high, while under more fortunate conditions it reaches much above one's head. It closely resembles cocklebur when young, but as it grows larger has more the appearance of the common sunflower, with flowers, however, after the pattern of the ragweed." *Arthur.*

AMBROSIA, Tourn. RAGWEED.

A. trifida, L. Great Ragweed.

Abundance and range nearly like the last; a similarly vile weed.

A. trifida, L., var. **integrifolia**, Torr. & Gray. Smaller Ragweed.

Hennepin county, *Herrick;* Blue Earth county, *Leiberg.*

A. artemisiæfolia, L. Roman Wormwood. Hog-weed. Bitter-weed.

Common or frequent, through the south half of the state; extending northwesterly to Pembina in the Red river valley, *Havard*, and to the Saskatchewan river.

A. psilostachya, DC. Western Ragweed.

Frequent through the south half of the state; common in the Red river valley; also found at the lake of the Woods, *Dawson.*

XANTHIUM, Tourn. COCKLEBUR. CLOTBUR.

X. Canadense, Mill. (X. strumarium, in *Manual.*) Common Cocklebur.

Frequent, or common, through the south half of the state; extending north to the northwest side of Mille Lacs (common), and the Red river valley; found at the lake of the Woods, *Dawson.* (A variety of this species, having no pubescence between the prickles of the fruit, is common, occurring in company with the ordinary type, in Blue Earth county and along the Minnesota river. *Leiberg.*)

X. Canadense, Mill., var. **echinatum**, Gray. Cocklebur.

Banks of Spirit lake, and head-waters of Little Sioux river, *Geyer;* banks of the Red river (abundant), *Dawson, Scott;* and on the shore of lake Superior.

HELIOPSIS, Pers. OX-EYE. FALSE SUNFLOWER.

H. lævis, Pers. Ox-eye. False Sunflower.

North of lake Superior (common), *Juni, Roberts*; upper Mississippi river, *Garrison;* Pembina, *Chickering.* Perhaps these references should be placed instead under the following species, which certainly is the prevailing representative of the genus in this state.

H. scabra, Dunal.* (H. lævis, Pers., var. scabra, Torr. & Gray.) Ox-eye. False Sunflower.

Red river prairie, *Dawson, Scott, Havard;* Todd county, also Minneapolis and Steele county (common), *Upham;* Stearns county, *Garrison;* Anoka county and New Ulm, *Juni;* Martin county and Emmet county, Iowa (abundant), *Cratty;* Blue Earth county, *Gedge*

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* HELIOPSIS SCABRA, Dunal. Hispidulous-scabrous, especially the leaves, 2 to 4 feet high: leaves from broadly ovate and subcordate to ovate-lanceolate, the upper occasionally entire: rays oblong, nearly or quite an inch in length: akenes smooth, but the angles above pubescent when young, the summit usually bearing an obscure or evident and irregular coroniform chaffy pappus, or sometimes 2 or 3 conspicuous and rigid teeth! Otherwise as the foregoing, into which it may pass. *Gray's Synoptical Flora of N. A.*

ECHINACEA, Mœnch. PURPLE CONE-FLOWER.

E. angustifolia, DC. Narrow-leaved Purple Cone-flower.

Abundant south and southwest; extending north to Anoka county, *Juni*, Stearns county, *Campbell*, Grant county, *Roberts*, and Clay county (common), *Upham*. (The club-shaped stems, six to nine inches high, remain standing through the winter.)

RUDBECKIA, L. CONE-FLOWER.

R. laciniata, L. Cone-flower.

Common, or frequent, through the south half of the state and in the Red river valley; on Roseau river, *Dawson*.

R. subtomentosa, Pursh. Cone-flower.

Lapham. Stearns county, *Garrison*. Southeast.

R. hirta, L. Cone-flower.

Common, occasionally abundant, throughout the state, excepting perhaps northeastward.

LEPACHYS, Raf. LEPACHYS.

L. pinnata, Torr. & Gray. Lepachys.

Frequent, in some places abundant, southward; extending north to Minneapolis (common) *Roberts*, Stearns county, *Campbell*, and in the Red river valley to Clay county (common), *Upham*, and Pembina, *Havard*.

L. columnaris, Torr. & Gray.* Lepachys.

Upper Minnesota river, *Geyer;* near Moorhead, *Leiberg*, and Glyndon, Clay county, *Gedge;* Pembina, *Scott*. West.

HELIANTHUS, L. SUNFLOWER.

H. petiolaris, Nutt.† Sunflower.

Dunes at Sand Hill river, Garfield, Polk county (lanceolate leaves, opposite on lower half of the stem; rays about 12, one to one and a half inches long; disk dark-purple), *Upham*. West.

H annuus, L.‡ (H. lenticularis, Dougl.) Sunflower.

Frequent in the Red river valley; Saint Vincent, Grand Forks, and Norman county, *Upham*. West. (Indigenous throughout the western half of the United States; referred to H. annuus, L., the cultivated sunflower, as its original and typical form, by Gray in the *Botany of California* and *American Journal of Science*, series 3, xxv, 245. "Gigantesque forms everywhere commonly cultivated," and occasionally adventive.)

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*LEPACHYS COLUMNARIS, Torr. & Gray. Strigose-scabrous, branched from the base, 1 to 2 feet high; radical leaves usually undivided, spatulate-lanceolate, cauline ones pinnately parted, the upper sessile, segments linear-lanceolate or oblong, rigid, mucronulate, entire, rarely somewhat lobed; disk columnar, longer than the 5 to 8 oblong or obovate-oval, recurved, yellow rays; chaff with woolly tips. Disk 1 inch or more long. *Porter and Coulter's Flora of Colorado.*

†HELIANTHUS PETIOLARIS, Nutt. Stem erect, 1 to 3 feet high, strigose or hispid, branching; leaves scabrous, alternate, the lower sometimes opposite, ovate-lanceolate or ovate, entire or somewhat repand-toothed, 3-nerved, on very long, slender, scabrous petioles; peduncles terminal, naked, bearing solitary (usually large) heads; scales of the involucre lanceolate, acute or acuminate; disk-flowers pubescent at base; achenia villous; pappus of two chaffy awns. Heads very variable in size. *Porter and Coulter's Flora of Colorado.*

‡See description of HELIANTHUS ANNUUS, L., on next page.

H. rigidus, Desf. Sunflower.

Common through the south half of the state and in the Red river valley; one to three feet high on the natural prairie; persisting as a troublesome weed in wheat-fields during the first two or three years of cultivation, there growing from three to five feet in hight.

H. lætiflorus, Pers. Sunflower.

Martin county, *Gedge;* Blue Earth county, *Leiberg;* Redwood, Todd (common), Wadena and Polk counties, *Upham;* Pembina, *Havard.* South and west.

H. occidentalis, Riddell. Sunflower.

St. Croix river, *Parry;* plentiful near lake Johanna, Ramsey county, *Roberts, Herrick;* lake Pepin, *Miss Manning.* Infrequent. Southeast.

H. Maximiliani, Schrader.* Sunflower.

Common in the south half of the state; reaching eastward at least to Minneapolis, where it is plentiful; also abundant in the Red river valley; extending northwest to the Saskatchewan river (Gray's *Synoptical Flora of N. A.*). Usually from nine to eighteen inches high, or sometimes three to five feet, on the natural prairie; but continuing as the most troublesome weed in wheat-fields, where it commonly grows four to six feet in hight and sometimes eight feet or more; foliage dull, grayish green; flowers showy, occasionally double (with all the corollas ligulate), blooming from July to September. The most noteworthy member of this genus in Minnesota. West and south.

Determined by *Prof. Asa Gray;* previously supposed, by the local botanists of the state, to be H. giganteus, L.; in Dr. Lapham's catalogue, it appears to be called H. tomentosus, Michx.; to *R. I. Cratty* and *J. C. Arthur* belongs the credit of obtaining its correct identification. (See Arthur's *Contributions to the Flora of Iowa*, No. V, and his note respecting this species in the *Botanical Gazette*, viii, p. 339. Dr. George Engelmann wrote me, Dec. 27, 1883: "The notice in the *Botanical Gazette* about Helianthus Maximiliani, wondering that it was found so far north, in Minnesota, is founded on error. The species comes originally from the upper Missouri, latitude of Minnesota, and has often been collected in Minnesota also by me; but extends, like many prairie plants, through many degrees of latitude, to Texas.")

H. giganteus, L. Sunflower.

St. Croix river, *Parry;* lake Pepin, *Miss Manning;* Minneapolis, *Twining;* north of lake Superior, *Roberts;* and northwest to the Saskatchewan river, Gray's *Synoptical Flora of N. A.* Infrequent. East and north.

H. grosse-serratus, Martens. Sunflower.

Moist prairies, Minnesota river, *Geyer;* abundant in Martin county and in Emmet county, Iowa, *Cratty;* lake Pepin, *Miss Manning;* moist land, Minneapolis, and Red-

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HELIANTHUS ANNUUS, L. (H. lenticularis, Dougl.) Annual, scabrous and even hispid; stems purple-spotted, stout, 3 to 8 feet high, branching: leaves alternate, ovate, acuminate, coarsely serrate, 3 to 6 inches long, 2 to 4 inches broad, 3-nerved at the base and suddenly narrowed into a petiole nearly as long as the leaf; uppermost leaves more lanceolate; heads mostly panicled, peduncled, 2½ to 4 inches broad; involucre spreading; the numerous ovate ciliate abruptly acuminate scales imbricated in about 3 rows, outer ones shortest; rays 20 to 24 [to 40], large; chaff of the flat receptacle nearly as long as the purplish disk-flowers, concave, carinate, tricuspidate, the middle point much the strongest and dark-colored; achenia finely appressed-pubescent; pappus of two lanceolate chaffy awns. *Eaton* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

*HELIANTHUS MAXIMILIANI, Schrad. Stem strigose-scabrous, branched; leaves alternate (those of the branches sometimes opposite), lanceolate, entire or nearly so, tapering to each end, acuminate, very scabrous and often canescent-strigose on both sides, the lower petioled; scales of the involucre lanceolate-subulate, much attenuate, strigose-canescent; pappus of two lanceolate slightly fringed chaffy scales. *Arthur's Contributions to the Flora of Iowa*, No. V, from *Torrey and Gray's Flora of N. A.*

wood, Stearns and Pope counties (common), *Upham;* less frequent, or wanting, in the Red river valley; four to eight feet high; leaves dark green, coarsely toothed, with intervals varying from a quarter to two-thirds of an inch between the teeth. South.

H. strumosus, L. Sunflower.

Through the south half of the state, infrequent. Douglas county, *Mrs. Terry;* New Ulm, *Juni;* Blue Earth county, *Leiberg;* Minneapolis, *Twining, Kassube;* lake Pepin, *Miss Manning.* [The var. mollis, Torr. & Gray, probably also occurs in this state.]

H. divaricatus, L. Sunflower.

Minneapolis, etc. (common), *Roberts;* Saskatchewan river, Gray's *Synoptical Flora of N. A.* South and west.

H. hirsutus, Raf. Sunflower.

Minneapolis, *Twining, Upham;* Worthington, Nobles county (common), *Foote.* South.

H. tracheliifolius, Willd. Sunflower.

Frequent, or common, throughout the state, excepting northeastward. Minneapolis, *Roberts;* lake Pepin, *Miss Manning;* upper Mississippi river, *Garrison;* Pembina, *Havard;* Rice (common), Morrison and Polk counties (often showing forms intermediate between this and the next, partaking of the characters of both), *Upham.*

H. decapetalus, L. Sunflower.

Lapham. Anoka county, also New Ulm (common), *Juni;* Stearns county, etc., *Upham.* [The form called var. frondosus, in Gray's *Manual*, has been observed in Stearns county by *Garrison.*]

H. tuberosus, L. (H. doronicoides, in *Manual.*) Sunflower. (Original of Jerusalem Artichoke.)

Throughout the state. Minnesota and St. Croix rivers, *Parry;* Redwood Falls, *Miss Butler;* New Ulm (common), *Juni;* upper Mississippi river, *Garrison;* common in the valley of the St. Louis river and northeasterly, *Clark;* extending northwest to the Saskatchewan river, Gray's *Synoptical Flora of N. A.*

H. tuberosus, L., var. **subcanescens**, Gray. Sunflower.

Mostly dwarf (about two feet high), comparatively small-leaved, rough-hispidulous or scabrous, but the lower face of the leaves whitish with soft and fine pubescence.—Plains of Minnesota, Dakota, etc., *Kennicott, Coues, Ward,* sometimes with well-developed tubers. Gray's *Synoptical Flora of N. A.*

COREOPSIS, L. TICKSEED.

C. lanceolata, L. Tickseed.

Lapham. Rare. Southeast.

C. tinctoria, Nutt.* Tickseed.

Low ground, Saskatchewan and Minnesota to Louisiana, Texas and Arizona. Gray's *Synoptical Flora of N. A.*

C. palmata, Nutt. Tickseed.

Common through the south half of the state; extending north to the upper Mississippi river, *Houghton, Garrison,* and northwest to Winnipeg, Gray's *Synoptical Flora of N. A.*

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*COREOPSIS TINCTORIA, Nutt. Annual: glabrous, 2 or 3 feet high: leaves opposite; radical and some lower cauline leaves 2-pinnately divided into lanceolate or linear divisions; upper with 3 to 7 linear divisions: outer involucre short and close: rays from half to three-fourths inch long, sometimes base only, sometimes nearly all crimson-brown: akenes oblong, thinnish, moderately incurved, wingless; pappus none or an obscure border. *Gray's Synoptical Flora of N. A.*

C. aristosa, Michx. Tickseed.

Anoka county, *Juni;* peat bogs, Blue Earth county, *Leiberg.* Infrequent. South.

C. trichosperma, Michx. Tickseed Sunflower.

Lapham. Saint Paul, *Kelley.* Southeast.

BIDENS, Tourn. BUR-MARIGOLD.

B. frondosa, L. Common Beggar-ticks. Stick-tight.

Common, or frequent, throughout the state.

B. connata, Muhl. Swamp Beggar-ticks.

Lapham. Blue Earth county, *Leiberg;* Minneapolis, *Roberts.* South.

B. cernua, L. Smaller Bur-Marigold.

Common north of lake Superior, *Roberts*, and at Glenwood, Pope county, *Upham;* Stearns county, *Campbell;* Anoka county, also New Ulm, *Juni;* Ramsey county, *Kelley;* lake Pepin, *Miss Manning;* Nobles county, *Leiberg;* not common southward, nor in the Red river valley.

B. chrysanthemoides, Michx. Larger Bur-Marigold.

Common throughout the state.

B. Beckii, Torr. Water Marigold.

St. Croix river to the sources of the Mississippi, *Houghton;* lake of the Woods, *Dawson;* Minneapolis (common), *Roberts.* Probably frequent throughout the state.

DYSODIA, Cav. FETID MARIGOLD.

D. chrysanthemoides, Lag. Fetid Marigold.

Nobles county, *Leiberg.* Infrequent. South.

GAILLARDIA, Fougeroux. GAILLARDIA.

G. aristata, Pursh.* Gaillardia.

Lapham. Red river valley, in Clay county, *Gedge*, Marshall county, *Winchell*, and near Saint Vincent, *Scott.* West.

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*GAILLARDIA, Fougeroux. Heads many-flowered, radiate; rays neutral, deciduous, many-nerved, the apex trifid; disk-flowers perfect, the tube short, the 5-cleft limb hispid with articulate usually colored hairs. Receptacle convex, usually fimbrillate. Involucral scales in two or three series, from a rigid base, running into a leafy appendage longer than the disk. Branches of the style terminated by a long awl-shaped hispid appendage. Achenia oblong or inversely pyramidal, villous. Pappus of 6 to 10 membranous or hyaline scales, the midnerve produced into a slender awn.—North American herbs more or less pubescent or glandular. Leaves alternate, the lower ones petioled and often lobed, the upper sessile and entire. Heads on long naked peduncles. Rays yellow, often saffron-colored or brownish-purple at the base. Disk-flowers yellow or violet. *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

G. ARISTATA, Pursh. Perennial, villous-pubescent or almost tomentose with jointed hairs; stem simple or branched, 1 to 2 feet high; leaves minutely punctate; radical and lower ones lanceolate, tapering into slender petioles, sinuate pinnatifid or coarsely toothed, minutely serrate or nearly entire; the uppermost linear or oblong-lanceolate, sessile, usually dilated at the base and partly clasping; heads large, 1½ to 2½ inches in diameter, including the rays; involucre hirsute; corollas of the disk with short, broadly subulate teeth, of a rich brownish-purple or maroon color; rays 10 to 18, crowded, elongated-cuneiform, deep yellow; chaff of the pappus 6 to 8, broadly lanceolate; fimbrillæ of the receptacle few, aristæform, slender, distinct, not dilated at the base, 2 to 3 times the length of the nearly smooth achenia. *Porter and Coulter's Flora of Colorado.*

G. pinnatifida, Torr.* Gaillardia.

Red river prairie, *Dawson.* West (mostly southwest). [Perhaps more correctly referable to the preceding species.]

HELENIUM, L. SNEEZE-WEED.

H. autumnale, L. Sneeze-weed.

Common through the south half of the state and in the Red river valley; extending northeastward at least to the upper Mississippi river, *Garrison.*

ANTHEMIS, L. CHAMOMILE.

A. Cotula, L. (*Maruta Cotula,* DC.) *May-weed. Dog Fennel.*

A common, often abundant, weed in the southern two-thirds of the state; less frequent in clearings of the forest farther north; also less common westward, and scarce from Ada northward in the Red river valley.

A. nobilis, L. *Garden Chamomile.*

Adventive, Beaver Bay, *Juni.*

ACHILLEA, Vaill. YARROW.

A. Millefolium, L. Common Yarrow or Milfoil.

Common throughout the state. The following notes describe this species on the north shore of lake Superior: "Abundant all along the shore, forming a fringe of white just on the line between the forest trees and the waves; was not found in other situations." *Juni.*—"The rose-colored variety occurs sparingly, showing all shades of color from white to a quite deep pink." *Roberts.*

CHRYSANTHEMUM, Tourn. CHRYSANTHEMUM.

C. Leucanthemum, L. (*Leucanthemum vulgare,* Lam.) *Ox-eye Daisy. White-weed.*

Lake City, *Miss Manning;* Stillwater, *Miss Field;* Mankato, *Prof. Bechdolt;* Minneapolis (frequent), *Roberts;* Saint Cloud, *Campbell;* upper Mississippi river, *Garrison.* Rare or local; inclined to spread; an abundant and pernicious weed in states farther east.

TANACETUM, Tourn. TANSY.

T. vulgare, L. *Common Tansy.*

Adventive: lake Pepin; Goodhue county; Minneapolis; Blue Earth county; Emmet county, Iowa.

T. Huronense, Nutt. Lake Huron Tansy.

Upper Mississippi river, *Garrison.* Infrequent. North.

ARTEMISIA, Tourn. WORMWOOD.

A. glauca, Pall.† Wormwood.

Saskatchewan and Minnesota, *Drummond, Nicollet, Kennicott.* (*Gray's Synoptical Flora of N. A.*)

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*GAILLARDIA PINNATIFIDA, Torr. Perennial, canescent; stems 8 to 12 inches high, branching; leaves sessile, pinnatifid, the rachis and remote lobes linear; heads rather small; involucre in about two series, nearly equal to the disk; rays deeply 3-cleft; chaff of the pappus lanceolate; fimbrillæ of the receptacle aristæform, slender, sparse, longer than the achenia. *Porter and Coulter's Flora of Colorado.*—A showy flower; heads 1 to 2 inches broad; rays yellow, or purple toward the base; disk-flowers purplish: leaves 1 to 3 inches long. *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

† See description of ARTEMISIA GLAUCA, Pall., on next page.

A. dracunculoides, Pursh. Wormwood.

Common through the south half of the state, and probably occurring also, but less frequently, in the Red river valley; extending northeast to Crow Wing and Todd counties, *Upham*.

A. borealis, Pallas. Wormwood.

Upper Mississippi river, *Garrison*. North. [Probably the var. WORMSKIOLDII, Bess., which is taller, 10 to 16 inches high, with more numerous heads in looser or compound narrower thyrsus. *Gray's Synoptical Flora of N. A.*]

A. Canadensis, Michx. Wormwood.

Lake Superior to sources of the Mississippi, *Houghton*, *Garrison;* lake of the Woods, *Dawson;* Red river valley, *Scott;* White Bear, Ramsey county, *Kelley*. North.

A. caudata, Michx. Wormwood.

Common through the south half of the state; abundant (frequently having galls) in the Red river valley, *Upham*.

A. serrata, Nutt.* Wormwood.

Prairies and low grounds, Illinois to Dakota; first collected by *Nuttall*. (Gray's *Synoptical Flora of N. A.*)

A. longifolia, Nutt.† Wormwood.

Rocky banks, Minnesota and Nebraska to Saskatchewan and Montana; first collected by *Nuttall*, or by *Lewis and Clarke*. (Gray's *Synoptical Flora of N. A.*)

A. Ludoviciana, Nutt. Western Mugwort. "Sage."

The form with incised or subpinnatifid leaves is occasionally found through the south half of the state and in the Red river valley, *Upham*. This is not regarded by Gray's *Synoptical Flora* as distinct from the form with undivided leaves (var. gnaphalodes, in *Manual*), which has been noted as follows: Minneapolis, *Roberts;* Blue Earth county, *Leiberg;* abundant in Martin county, and in Emmet county, Iowa, *Cratty;* Red river valley (common), *Upham*, *Scott*. (*Mr. Arthur* states that the first of these forms is infrequent or rare in Iowa; but that the second is common there. Specimens of this species sent by *Prof. Gedge* from Marshall, Lyon county, in rich soil near the Redwood river, have the broadly lanceolate leaves all entire or only sparingly toothed, with their upper surface nearly glabrate and green; as is said by Gray's *Synoptical Flora* to be sometimes their condition.)

A. biennis, Willd. Biennial Wormwood.

Frequent, often common, throughout the state.

A. Absinthium, L. *Common Garden Wormwood.*

Lapham. Blue Earth county, *Leiberg*. Rarely adventive.

ARTEMISIA GLAUCA, Pall. Minutely silky pubescent or canescent, sometimes glabrate and glaucous: stems strict, a foot or two high, somewhat woody at base: leaves rather short, from linear- to oblong-lanceolate, mostly entire, occasionally some 3-cleft, or the lowest even more divided: heads nearly of the next, into which it probably passes. *Gray's Synoptical Flora of N. A.*

*ARTEMISIA SERRATA, Nutt. Stems 6 to 9 feet high, very leafy; leaves green and glabrous above, white-tomentose beneath, lanceolate or uppermost linear, 3 to 7 inches long, all serrate with sharp narrow teeth, pinnately veined, the earliest sometimes pinnately incised: heads amply paniculate, rather few-flowered, less than two lines long, greenish, hardly pubescent. *Gray's Synoptical Flora of N. A.*

†ARTEMISIA LONGIFOLIA, Nutt. Stem 2 to 5 feet high: leaves entire, at first tomentulose, but usually glabrate above, white tomentose beneath, linear or linear-lanceolate (3 to 7 inches long, 1 to 5 lines wide); veins obsolete: heads amply paniculate, usually canescent, 2 to 3 lines long. *Gray's Synoptical Flora of N. A.*

A. frigida, Willd. Wormwood. "Sage."

Lake Superior; "rising ground, east of the Red river prairie," *Dawson*, *Scott*; and southward to Minneapolis (plentiful on the river bluffs below the falls of St. Anthony) and Fort Snelling, lake Pepin, *Miss Manning*, and Pipestone county, *Leiberg*, *Mrs. Bennett*. Local.

GNAPHALIUM, L. CUDWEED. EVERLASTING.

G. decurrens, Ives. Everlasting.

North shore of lake Superior (Deronda bay and Grand Portage island), *Juni*; Nicollet county, *Gedge*. Infrequent. Northeast.

G. polycephalum, Michx. Common Everlasting.

Throughout the state, but infrequent. Lake Superior, *Whitney*; lake of the Woods, *Dawson*; St. Croix Falls, *Miss Field*; lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg*.

G. uliginosum, L. Low Cudweed.

Lapham. Pipestone county, *Mrs. Bennett*. Infrequent.

ANAPHALIS, DC. EVERLASTING.

A. margaritacea, Benth. & Hook. (Antennaria margaritacea, R. Br.) Pearly Everlasting.

Common at Beaver Bay (north shore of lake Superior), and at Minneapolis, *Roberts*; Wadena county, etc., *Upham*; Blue Earth county, *Leiberg*. Throughout. Local.

ANTENNARIA, Gærtn. EVERLASTING.

A. plantaginifolia, Hook. Plantain-leaved Everlasting.

Common, or abundant, throughout the state.

ERECHTITES, Raf. FIREWEED.

E. hieracifolia, Raf. Fireweed.

Stearns county, *Garrison*; Douglas county, *Mrs. Terry*; falls of the St. Croix, *Parry*; Minneapolis, *Kassube*; lake Pepin, *Miss Manning*; Anoka county, also New Ulm, *Juni*; Blue Earth county (common), *Leiberg*. South.

CACALIA, L. INDIAN PLANTAIN.

C. reniformis, Muhl. Great Indian Plantain.

Fillmore county, *Winchell*; lake Pepin, *Miss Manning*; Hennepin county, *Herrick*. Infrequent. South.

C. atriplicifolia, L. Pale Indian Plantain.

Goodhue county, *Sandberg*. Southeast.

C. tuberosa, Nutt. Tuberous Indian Plantain.

Dakota county (frequent), *Upham*; Steele county, *Miss Bixby*; Blue Earth county, *Leiberg*; New Ulm, *Juni*; common in Martin county and in Emmet county, Iowa, *Cratty*. South.

SENECIO, Tourn. GROUNDSEL.

S. vulgaris, L. *Common Groundsel.*

Mankato (frequent), *Leiberg*; Saint Paul, *Kelley*.

S. palustris, Hook. Groundsel.

Common, or frequent, through the northernand central portions of the state:

extending eastward at least to the St. Louis river, *Mrs. Herrick*, Morrison county and Minneapolis, *Upham*, Goodhue county, *Sandberg*, and lake Pepin, *Miss Manning;* abundant about lakes in Grant county, *Roberts*, and in swamps near New Ulm, *Juni;* very rare in Emmet county, Iowa, *Cratty*.

S. integerrimus, Nutt.* Groundsel.

Lapham. West.

S. aureus, L. Golden Ragwort. Squaw-weed. Life-root.

Common, or frequent, throughout the state, in some portions abundant.

S. aureus, L., var. **obovatus**, Torr. & Gray. Golden Ragwort. Squaw-weed.

Minneapolis, *Kassube*; Pipestone county, *Mrs. Bennett;* and perhaps throughout the state.

S. aureus, L., var. **Balsamitæ**, Torr. & Gray. Golden Ragwort. Squaw-weed.

Throughout the state. North of lake Superior, *Agassiz*; Pembina, *Chickering;* Pokegama Falls, *Houghton*; Minneapolis, *Roberts*.

S. canus, Hook.† Groundsel.

Put in bay, north shore of lake Superior, *Juni*. North.

S. lugens, Richardson.‡ (Including var. Hookeri, Eaton.) Groundsel.

Red river valley near Moorhead, *Leiberg;* Pipestone county, *Mrs. Bennett*. [Also Plymouth county, in northwestern Iowa, *Arthur*.] West.

ARNICA, L. ARNICA.

A. Chamissonis, Less. (A. mollis, Hook.) Arnica

North shore of lake Superior, *Juni*. North.

CENTAUREA, L. STAR THISTLE.

C. Cyanus, L. *Blue-bottle. Bachelor's-Button.*

Escaped from gardens, Blue Earth county, *Leiberg*.

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*SENECIO INTEGERRIMUS, Nutt. Glabrous throughout; stem simple, striate, 12 to 18 inches high; leaves entire; radical ones 3 to 5 inches long and 1 to 2 inches wide, rather obtuse, tapering into a petiole, somewhat fleshy, upper small, lanceolate, acute, partly clasping; corymb simple or nearly so; heads rather large, 8 to 20; involucre hemispherical, bracteolate, scales 15 to 20, narrowly linear, acute; rays about 8, small; disk-flowers 40 to 50; achenia striate, nearly glabrous. *Porter and Coulter's Flora of Colorado*.

†SENECIO CANUS, Hook. Whitish tomentose throughout; stems tufted, 2 to 12 inches high; radical leaves obovate, obtuse, narrowed into short petioles; the cauline sessile, lanceolate, pinnately cleft, or with a few teeth near the base, rarely entire; heads rather large, few in a simple corymb; involucre nearly ecalyculate; rays 8 to 12, not twice as long as the involucre; achenia glabrous. *Eaton* in *Bot. Rep. of King's Expl. of the Fortieth Parallel*.

‡SENECIO LUGENS, Richardson. Lightly floccose-woolly when young, in the typical form early glabrate and bright green: stem 6 inches to 2 feet high, few- and small-leaved and naked above, terminated by a cyme of several or rather numerous heads (these about five lines high): radical and lower cauline leaves spatulate, varying to oval or oblong, either gradually or abruptly contracted at base into a winged or margined short petiole, usually repand- or callous-denticulate; upper cauline lanceolate or reduced and bract-like; bracts of the campanulate involucre lanceolate, with obtuse or acutish commonly blackish-sphacelate tips: heads many-flowered: rays 10 or 12, conspicuous. *Gray's Synoptical Flora of N. A.*

CNICUS, Tourn. (Included in CIRSIUM by *Manual.*) THISTLE.

C. lanceolatus, Hoffm. *Common Thistle.*

Frequent, but seldom plentiful, throughout the state. North of lake Superior, *Juni;* Pembina, *Havard;* Minneapolis, *Griswold, Kassube;* lake Pepin, *Miss Manning;* Wabasha, *Gibson;* Nicollet county, *Aiton;* Blue Earth county and southward (common), *Leiberg.*

C. Pitcheri, Torr. Pitcher's Thistle.

North shore of lake Superior, *Macoun;* doubtless in Minnesota.

C. undulatus, Gray. Thistle. •

North of lake Superior (in a grass field at Grand Marais, said to have made its first appearance in 1878), *Roberts.* [Near Fort Pierre, Dakota, *Geyer.*] Plains, &c., from lake Huron and Minnesota to Saskatchewan, west to Oregon, south to Kansas and New Mexico. *Gray's Synoptical Flora of N. A.*

C. undulatus, Gray, var. **canescens**, Gray. Thistle.

Merely a form with smaller heads, sometimes not over an inch long, the leaves varying from ciliately spinulose-dentate to deeply pinnatifid.—Minnesota to New Mexico and southern Utah. *Gray's Synoptical Flora of N. A.*

C. undulatus, Gray, var. **megacephalus**, Gray. Thistle.

Stouter form, usually broader-leaved, with broad heads 2 inches or more long.—Minnesota and Texas to Idaho. *Gray's Synoptical Flora of N. A.*

C. altissimus, Willd. Tall Thistle.

Lake Pepin, *Miss Manning;* Minneapolis, *Simmons;* Faribault, *Miss Beane;* Blue Earth county, *Leiberg;* abundant in Martin county, and in Emmet county, Iowa, *Cratty;* common northwestward and in the Red river valley, *Upham, Scott.* South and west.

C. altissimus, Willd., var. **discolor**, Gray. (C. discolor, Muhl.) Thistle.

Minneapolis, *Kassube, Roberts, Simmons;* Hesper, Iowa (common), *Mrs. Carter;* Worthington (common), *Foote;* Redwood Falls, *Pemberton;* Anoka county, *Juni;* Stearns county, *Garrison;* Clay county, *Upham;* Pembina, *Havard.* South and west.

C. muticus, Pursh. Swamp Thistle.

Common, or frequent, throughout the state.

C. pumilus, Torr. Pasture Thistle.

Goodhue county, *Sandberg;* Dakota county (frequent), *Upham;* Anoka county, *Juni;* Stearns county, *Garrison;* Alexandria, Douglas county, *Mrs. Terry.* South.

C. arvensis, Hoffm. *Canada Thistle.* ●

Newburgh, Fillmore county, *Mrs. Carter*; covering about an acre close west of Rochester, Olmsted county; a few miles east of Faribault; Stillwater, *Miss Field;* on Western avenue, at the west border of Minneapolis, spreading, *Roberts.* Rare, but likely to become common; in many districts farther east, "a most troublesome weed, extremely difficult to eradicate."

ONOPORDON, Vaill. COTTON THISTLE. SCOTCH THISTLE.

O. acanthium, L *Cotton Thistle. Scotch Thistle.*

Lake City, *Mrs. Ray.* Rare.

ARCTIUM, L. (LAPPA, Tourn.) BURDOCK.

A. Lappa, L. (*L. officinalis*, Allioni, var. *major*, Gray.) *Common Burdock.*

Common through the south half of the state, and probably northeastward; less frequent in the Red river valley.

CICHORIUM, Tourn. Succory. Chicory.

C. Intybus, L. *Succory. Chicory.*

Minneapolis, *Herrick*; near Excelsior, Hennepin county, *Mrs. Terry.* Rare.

KRIGIA, Schreber. (Including Cynthia, Don.) Krigia.

K. Virginica, Willd. Dwarf Dandelion.

Upper Mississippi river, *Garrison*. Rare.

K. amplexicaulis, Nutt. (Cynthia Virginica, Don.) Cynthia.

Common, or frequent, through the south half of the state; extending north at least to Morrison county (common), *Upham*, and the upper Mississippi river *Garrison*.

TROXIMON, Nutt. Troximon.

T. cuspidatum, Pursh. Troximon.

Common, or frequent, through the south and west portions of the state; extending northeast to lake Pepin, *Miss Manning*, Minneapolis, *Twining*, *Roberts*, Stearns county, *Campbell*, and Pembina, *Chickering*.

T. glaucum, Nutt.[*] Troximon.

Red river prairie, *Dawson*, *Havard;* near Glyndon, *Leiberg*, *Gedge;* Kittson, Stevens and Lincoln counties, *Upham*. West. [T. aurantiacum, Hook., has been reported, but probably erroneously, at Pembina.]

TRAGOPOGON, L. Goat's-Beard. Vegetable Oyster.

T. pratensis, L.[†] *Yellow Goat's-Beard.*

Naturalized in meadow of Spring creek near Red Wing, *Sandberg*.

HIERACIUM, Tourn. Hawkweed.

H. umbellatum, L.[‡] Hawkweed.

North shore of lake Superior to the Rocky mountains and northward, Gray's *Synoptical Flora of N. A.*; probably in northern Minnesota.

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[*] Troximon glaucum, Nutt. Usually a foot or two high, rather stout, pale or glaucous, either glabrous or with loose pubescence: leaves linear to lanceolate, from entire to sparingly dentate or sometimes laciniate, 4 to 12 inches long: involucre commonly an inch high and many-flowered; its bracts lanceolate or broader: outer series shorter, often pubescent, or even villous: akenes with apex tapering gradually into a rather stout and nerved beak which is shorter than the body; akenes with the beak 5 or 6 lines long, longer than the pappus, the copious and rather rigid bristles of which are (as in most species) only denticulate-scabrous. *Gray's Synoptical Flora of N. A.*

[†] Tragopogon, L. Involucre simple, of many leaves; receptacle naked; pappus plumous, achenia longitudinally striate, contracted into a long, filiform beak. Biennial European herbs, with long, linear, grass-like leaves. *Wood's Class-Book.*

T. pratensis, L. Leaves linear, those of the stem dilated at the base and abruptly acuminated into a slender point towards the apex, glabrous. Peduncles scarcely thickened beneath the anthodes [heads]. Florets yellow. Achenes with the beak about as long as the achene, ribbed; those of the outer florets usually muricated on the ribs. Pappus of all the florets of plumose hairs. *Sowerby's English Botany*, vol. v.

[‡] Hieracium umbellatum, L. Stem a foot or two high, strict, leafy to the top, bearing a few somewhat umbellately disposed heads: leaves narrowly or sometimes broadly lanceolate, nearly entire, sparsely denticulate, occasionally laciniate-dentate, all narrow at base; the cauline leaves all closely sessile: involucre half inch high, or sometimes smaller, usually livid, glabrous or nearly so: outermost bracts loose or spreading. *Gray's Synoptical Flora of N. A.*

H. Canadense, Michx. Canada Hawkweed.

Common, or frequent, throughout the state; abundant north of lake Superior, *Roberts.*

H. scabrum, Michx. Rough Hawkweed.

St. Croix river, *Parry;* Saint Cloud, *Campbell;* Beaver Bay, *Roberts;* Pembina, *Chickering.* (A hawkweed agreeing with Gray's description of this species in bearing 40- to 50-flowered heads, but in other characters like H. paniculatum, grows in the Red river valley on moist prairie, *Upham.*)

H. longipilum, Torr. Long-bearded Hawkweed.

St. Croix river, *Parry;* Blue Earth county, *Leiberg.* Rare. South.

H. venosum, L. Rattlesnake-weed.

Red river prairie, *Dawson, Scott.* Infrequent.

PRENANTHES, Vaill. (Including NABALUS, Cass.) RATTLESNAKE-ROOT.

P. alba, L. White Lettuce. Rattlesnake-root.

Common throughout the state.

P. serpentaria, Pursh.* (N. albus, Hook., var. serpentaria, Gray.) Rattlesnake-root.

Hennepin county, *Herrick;* Stearns county, *Campbell.* [Devil's lake, Dakota, *Geyer.*]

P. altissima, L. Tall White Lettuce.

Between lake Superior and the lake of the Woods, *Macoun.*

P. racemosa, Michx. Rattlesnake-root.

Frequent, or common, throughout the state.

P. aspera, Michx. Rattlesnake-root.

Frequent through the south half of the state; extending north to Stearns county, *Campbell,* and Douglas county, *Mrs. Terry.*

P. crepidinea, Michx. Rattlesnake-root.

Lake Benton, Lincoln county, *Upham.* Infrequent. South.

LYGODESMIA, Don. LYGODESMIA.

L. juncea, Don. Lygodesmia.

Common southwestward, on sandy land; extending north and east to Muskoda, Clay county, and Sand Hill river, *Upham,* Pembina, *Havard,* Meeker county, *Campbell,* Minneapolis, *Roberts,* St. Croix river, *Sweezy,* and Blue Earth county, *Leiberg.*

[Crepis runcinata, Torr. & Gray, whose eastern limit extends from the Saskatchewan region to Nebraska and Iowa (*Arthur*), and the nearly related C. glauca, Torr. & Gray, of similar range, seem likely to be found in western Minnesota.]

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* PRENANTHES SERPENTARIA, Pursh. Commonly 2 feet high, glabrous or a little hirsute-pubescent: stem sometimes purple-spotted, rather stout: leaves diversely variable, assuming all the forms of the preceding species: inflorescence corymbosely thyrsoid-paniculate; the heads mostly glomerate at summit of ascending or spreading flowering-branches or peduncles: involucre green, rarely purplish-tinged, 8- to 12-flowered; flowers purplish, greenish white or ochroleucous: pappus sordid straw-color or whitish. . . . Open grounds, commonly in sandy or sterile soil. *Gray's Synoptical Flora of N. A.*

TARAXACUM, Haller. Dandelion.

T. officinale, Weber. (T. Dens-leonis, Desf.) Common Dandelion.

Common, often abundant, throughout most of the state; but less frequent near its west side. It seems to be quite absent from some districts westward, as Cottonwood county, *Holzinger;* and occurs rarely in the Red river valley near Saint Vincent, *Dawson, Havard.*

LACTUCA, Tourn. (Including Mulgedium, Cass.) Lettuce.

L. Canadensis, L. Wild Lettuce.

Frequent throughout the state.

L. hirsuta, Muhl. (L. Canadensis, L., var. sanguinea, Torr. & Gray.) Wild Lettuce.

Minneapolis, *Roberts, Upham;* frequent in Martin county and in Emmet county, Iowa, *Cratty.* South.

L. pulchella, DC. (Mulgedium pulchellum, Nutt.) False or Blue Lettuce.

Red river valley at Pembina, *Havard,* and near Moorhead, *Leiberg;* lake Carlos, Douglas county, *Mrs. Terry;* Minneapolis, *A. W. Jones;* Lake Benton and Polk county, *Upham.* North and west.

L. Floridana, Gærtn. (M. Floridanum, DC.) False or Blue Lettuce.

Lapham. Winona county, *Holzinger;* Minneapolis, *A. W. Jones.* South.

L. leucophæa, Gray. (M. leucophæum, DC.) False or Blue Lettuce.

North of lake Superior, *Roberts;* lake of the Woods, *Dawson;* Pembina, *Havard;* Blue Earth county, *Leiberg.*

SONCHUS, Tourn. Sow-Thistle.

S. oleraceus, L. *Common Sow-Thistle.*

Saint Paul, *Kelley;* Minneapolis, *Miss Butler;* Nicollet county, *Aiton;* New Ulm, *Juni.* Infrequent.

S. asper, Vill. *Spiny-leaved Sow-Thistle.*

More frequent than the preceding: observed at Grand Marais and Beaver Bay, on the north shore of lake Superior; at Minneapolis; and in Goodhue, Winona, Rice and Blue Earth counties.

S. arvensis, L. *Field Sow-Thistle.*

Anoka county, *Juni.* Infrequent.

LOBELIACEÆ. Lobelia Family.

LOBELIA, L. Lobelia.

L. cardinalis, L. Cardinal Flower.

Along the Mississippi river at Wabasha, *Gibson,* lake Pepin, *Miss Manning,* and Saint Paul, *Mrs. Terry;* and the St. Croix river at Marine Mills, Washington county, *Miss Cathcart,* and at St. Croix Falls, *Miss Field.*

L. syphilitica, L. Great Lobelia.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river, *Garrison,* and the Red river valley, *Gedge.*

L. inflata, L. Indian Tobacco.

Lake St. Croix, *Parry;* St. Croix Falls, *Miss Field;* Blue Earth county, *Leiberg.* Infrequent.

L. spicata, Lam. Lobelia.

Common through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi, *Houghton*.

L. Kalmii, L. Kalm's Lobelia.

Common through the north half of the state and south to Minneapolis, *Roberts*, *Upham;* rare southward, as in peat bogs in the Minnesota valley between Kasota and Mankato, *Leiberg*.

L. Dortmanna, L. Water Lobelia.

Isle Royale, *Dr. A. B. Lyons;* doubtless in Minnesota north of lake Superior.

CAMPANULACEÆ. CAMPANULA FAMILY.

CAMPANULA, Tourn. BELLFLOWER.

C. rotundifolia, L. Harebell. Bluebell.

Common throughout the state. A very pretty flower, plentiful in all our prairie region and along the shore of lake Superior; in the latter situation varying through intermediate forms to the var. linifolia of Gray's *Manual*, *Roberts*.

C. aparinoides, Pursh. Marsh Bellflower.

Common throughout the state. (In the vicinity of Mankato, a bellflower is reported by *Leiberg* as common in bogs, agreeing well with the description of this species, except in the large size of the flowers, which have the corolla ⅝ to ¾ of an inch long, five times as long as the small calyx-lobes. The ordinary smaller-flowered form of this species has not been observed there. The large-flowered form has also been collected at Minneapolis.)

C. Americana, L. Tall Bellflower.

Frequent through the south part of the state; extending north to Douglas county, *Mrs. Terry*.

SPECULARIA, Heister. VENUS'S LOOKING-GLASS.

S. perfoliata, A. DC. Venus's Looking-Glass.

Lapham. Minneapolis, *Kassube;* near Saint Paul, *Mrs. Terry*. Infrequent. South.

ERICACEÆ. HEATH FAMILY.

GAYLUSSACIA, HBK. HUCKLEBERRY. WHORTLEBERRY.

G. resinosa, Torr. & Gray. Common Black Huckleberry.

Frequent, often common, northeastward; extending west to Cass lake, *Schoolcraft*, and south to the falls of Kettle river, in section 15, T. 42, R. 20, *Upham*.

VACCINIUM, L. CRANBERRY. BLUEBERRY. BILBERRY.

V. Oxycoccus, L. Small Cranberry.

Common northward; extending west to the upper Mississippi river, *Garrison*, Becker county, *Gedge*, and Fergus Falls, *Leonard;* and south to Anoka county (plentiful), *Roberts*, and White Bear lake, Ramsey county, *Kelley*.

V. macrocarpon, Ait. Large American Cranberry.

Common through the north half of the state, excepting the Red river valley and near the shore of lake Superior; extending south to Fergus Falls, *Leonard*, and Minneapolis, *Roberts*. Much gathered for the market, especially by the Chippewa Indians.

V. Vitis-Idæa, L. Cowberry.

North shore of lake Superior (swamps at Port Arthur), *Macoun;* doubtless in Minnesota.

V. stamineum, L. Deerberry. Squaw Huckleberry.

Near Saint Paul, *Mrs. Terry.* Rare.

V. uliginosum, L. Bog Bilberry.

North of lake Superior, *Juni.* North.

V. cæspitosum, Michx., var. **cuneifolium,** Nutt. Bilberry.

Margins of a lake near Stillwater, *Parry.* Rare. North.

[V. ovalifolium, Smith, and V. myrtilloides, Hook., will doubtless be found in Minnesota north of lake Superior.]

V. Pennsylvanicum, Lam. Dwarf or Low Blueberry.

Common in the north half of the state ; extending south to Minneapolis, *Roberts,* and lake Pepin, *Miss Manning,* the Mississippi river being its southwestern limit from Minneapolis to Morrison county, *Upham.*

V. Canadense, Kalm. Canada Blueberry.

Falls of the St. Croix river, *Parry;* Stearns county, *Garrison;* and northward.

V. corymbosum, L. Swamp or High Blueberry.

Lapham. Ramsey county (var. amœnum, Gray), *Winchell;* White Earth reservation, *Garrison.* Rare.

CHIOGENES, Salisb. Creeping Snowberry.

C. hispidula, Torr. & Gray. Creeping Snowberry.

Frequent northeastward ; extending south to Anoka county (plentiful in tamarack swamps), *Roberts;* Hennepin county, *Simmons.*

ARCTOSTAPHYLOS, Adans. Bearberry.

A. Uva-ursi, Spreng. Bearberry. Kinnikinnick.

Common, often abundant, on sandy land through the north half of the state ; extending south to Isanti and Sherburne counties (common), *Upham;* rare and local farther south, as in Goodhue county, *Sandberg,* at lake Pepin, *Miss Manning,* and on sandy knolls in section 12, Saratoga, Winona county, *Winchell.*

EPIGÆA, L. Mayflower. Trailing Arbutus. Ground Laurel.

E. repens, L. Mayflower. Trailing Arbutus. Ground Laurel.

Minnesota Point and elsewhere near Duluth, *Juni, Miss Cathcart;* falls of Kettle river, *Upham.* Infrequent. Northeast.

GAULTHERIA, Kalm. Aromatic Wintergreen.

G. procumbens, L. Aromatic Wintergreen. Checkerberry.

Common northeastward ; extending west and south to Rainy Lake river, *Keating,* the lake of the Woods, *Dawson,* Wadena county, *Upham,* and Anoka county, *Roberts,* rare farther southeast, as at lake Pepin, *Miss Manning,* and Mound Prairie, Houston county, *Winchell.*

CASSANDRA, Don. Leather-Leaf.

C. calyculata, Don. Leather-Leaf.

North of lake Superior (common), *Roberts;* lake of the Woods, *Dawson;* St. Croix river, *Parry;* extending south to Wadena (frequent) and Chisago counties, *Upham,* Minneapolis, *Kassube,* and Stillwater, *Miss Field.*

CASSIOPE, Don. CASSIOPE.

C. hypnoides, Don. Cassiope.

Minnesota Point, lake Superior, *Miss Cathcart*. Rare. North.

ANDROMEDA, L. ANDROMEDA.

A. polifolia, L. Wild Rosemary.

Plentiful near Grand Marais, and in swamps near lake Johanna, Ramsey county, *Roberts;* Minnesota Point, *Miss Cathcart;* lake of the Woods, and thence toward Red river, *Dawson;* St. Croix river, *Parry;* Chisago county, etc., *Upham;* near Minneapolis, *Kassube*. North.

KALMIA, L. AMERICAN LAUREL.

K. glauca, Ait. Pale Laurel.

Certainly to be found in northern Minnesota, *Macoun*.

MENZIESIA, Smith. MENZIESIA.

M. glabella, Gray.* Menziesia.

Minnesota Point, lake Superior, *Miss Cathcart*. (The *Botany of California* states that this [called M. ferruginea] extends east "nearly to the upper Great lakes.") Rare. Northwest.

LEDUM, L. LABRADOR TEA.

L. latifolium, Ait. Labrador Tea.

Common, often abundant, through the north half of the state; extending south to Sherburne and Anoka counties (common), *Roberts*, and near Saint Paul, *Mrs. Terry*. Used as tea by the Chippewa Indians.

PYROLA, Tourn. WINTERGREEN. SHIN-LEAF. PYRÓLA.

P. rotundifolia, L. Wintergreen. Shin-leaf.

Common through the north half of the state; extending south to Minneapolis (common), *Roberts*, and rare farther south, as at Cannon River Falls, *Blake*, *Sandberg*, and Chatfield, Fillmore county, *Winchell*.

P. rotundifolia, L., var. **incarnata**, DC. Wintergreen.

Detroit, Becker county, *Gedge*. North.

P. rotundifolia, L., var. **asarifolia**, Hook. Wintergreen.

St. Croix Falls, *Miss Field;* Saint Cloud, *Garrison*. [Lake Superior, *Whitney*.] North.

P. rotundifolia, L., var. **uliginosa**, Gray. Wintergreen.

Minneapolis (frequent), *Roberts*, *Winchell;* Morrison county (on dryish land in woods), *Upham*.

P. elliptica, Nutt. Wintergreen. Shin-leaf.

Common, or frequent, throughout the state.

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* MENZIESIA GLABELLA, Gray. Strigose-chaffy scales wanting, or very few on young petioles and midrib beneath; leaves obovate, mostly obtuse, barely mucronate-tipped, glaucescent and glabrous or nearly so beneath (an inch or two long), sprinkled with some small appressed hairs above, the obscurely serrulate margins minutely ciliolate: pedicels naked or somewhat glandular: corolla ovoid-campanulate. *Gray's Synoptical Flora of N. A.*

P. chlorantha, Swartz. Wintergreen. Shin-leaf.

Common, or frequent, through the north half of the state; extending south to Isanti county, *Upham.*

P. secunda, L. Wintergreen. Shin-leaf.

Common northward; extending south to the St. Croix river, *Parry*, Goodhue county, *Sandberg*, lake Pepin, *Miss Manning*, Blue Earth county, *Leiberg*, and Redwood Falls, *Pemberton.*

P. secunda, L., var. **pumila,** Paine. Wintergreen. Shin-leaf.

North of lake Superior, *Juni;* in tamarack swamps near Minneapolis, *Roberts.* Rare. North.

P. minor, L. Wintergreen. Shin-leaf.

North of lake Superior (in woods at Kakabeka falls), *Macoun;* doubtless in northern Minnesota.

MONESES, Salisb. MONESES. ONE-FLOWERED PYROLA.

M. uniflora, Gray. One-flowered Pyrola.

North of lake Superior (frequent), *Juni, Roberts;* Becker county, *Gedge;* Stearns county, *Campbell.* North.

CHIMAPHILA, Pursh. PIPSISSEWA. WINTERGREEN.

C. umbellata, Nutt. Prince's Pine. Pipsissewa. Wintergreen.

Frequent northward; extending south to Wadena county, *Upham*, Saint Cloud, *Campbell*, and Anoka county (at Deer lake), *Roberts;* near Minneapolis, *W. H. Hatch;* rare and local farther southeast, as in Goodhue county, *Sandberg*, at lake Pepin, *Miss Manning*, and Hesper, Iowa, *Mrs. Carter.*

C. maculata, Pursh. Spotted Wintergreen.

Clearwater, Wright county, *Mrs. Terry;* Saint Paul, *Miss Cathcart.* Rare.

[Pterospora andromedea, Nutt., will probably be found in northern Minnesota.]

MONOTROPA, L. INDIAN PIPE. PINE-SAP.

M. uniflora, L. Indian Pipe. Corpse-Plant.

Throughout the state: common, occasionally abundant, northward; infrequent or rare southward.

M. Hypopitys, L. Pine-sap. False Beech-drops.

Caribou Point and Carlton's Peak, north of lake Superior, also at Taylor's Falls, *Roberts.* Rare. North.

ILICINEÆ. (AQUIFOLIACEÆ.) HOLLY FAMILY.

ILEX, L. HOLLY.

I. verticillata, Gray. Black Alder. Winterberry.

St. Croix river, *Parry;* lake Pepin, *Miss Manning;* Saint Paul, *Kelley;* Minneapolis, *Winchell;* Stearns county, *Upham;* St. Louis river, *Mrs. Herrick.* North.

NEMOPANTHES, Raf. MOUNTAIN HOLLY.

N. Canadensis, DC. Mountain Holly.

Lapham. St. Croix river, *Parry;* lake Pepin, *Miss Manning.* Infrequent. North.

PLANTAGINACEÆ. PLANTAIN FAMILY.

PLANTAGO, Tourn. PLANTAIN. RIBWORT.

P. major, L. Common Plantain. Wayside Plantain.

Common, often abundant, throughout the state. Evidently indigenous in Rock county, *Leiberg*, and in the Red river valley (where a form occurs, very probably the var. Asiatica, Decaisne, coarser than ordinary, with scape and spike from 1½ to 2 feet high, the spike being 6 to 12 inches long), *Upham*. [Sheyenne river, Dakota, *Geyer*.]

P. Rugelii, Decaisne.* (P. Kamtschatica, Hook.) Plantain.

Blue Earth county (common), *Leiberg;* Martin county, *Cratty*. Perhaps frequent throughout the state, but overlooked on account of its resemblance to the preceding. (Indigenous; found only in America.)

[P. cordata, Lam., should be looked for in the east part of the state; and *P. lanceolata*, L., may be expected as a weed southeastward.]

P. eriopoda, Torr.† Plantain.

Red river valley, *Watson*, *Scott*. Northwest.

P. Patagonica, Jacq., var. **gnaphalioides**, Gray. Plantain.

Upper Minnesota river, *Parry;* New Ulm, *Juni*; Nicollet county, *Aiton;* Blue Earth county, *Leiberg;* common in Watab, Benton county, and frequent, often common, thence southwestward, *Upham;* plentiful at the Pipestone quarry (showing gradations in size to small matted plants with almost filiform scapes, none of which exceed two or three inches in hight, bearing few-flowered capitate spikes ⅛ to ¼ inch long), *Mrs. Bennett*. [Devil's lake, Dakota, *Geyer*.] South and west.

PRIMULACEÆ. PRIMROSE FAMILY.

PRIMULA, L. PRIMROSE. COWSLIP.

P. farinosa, L. Bird's-eye Primrose.

North shore of lake Superior, *Whitney*, *Macoun*; St. Croix lake, Stillwater, *Miss Field*. North.

P. Mistassinica, Michx. Primrose.

Lapham. Abundant on the north shore of lake Superior, *Juni*, *Roberts*. North.

ANDROSACE, Tourn. ANDROSACE.

A. occidentalis, Pursh. Androsace.

Blue Earth county (common), also a dwarfed form, about an inch high, with solitary flowers, found near South Bend, in this county, *Leiberg;* Pipestone county, *Mrs. Bennett;* Sauk Rapids, *Mrs. Blaisdell;* Walhalla, northeastern Dakota, *Scott.* South and west.

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* PLANTAGO RUGELII, Decaisne. Leaves paler [than in P. major], commonly thinner: spikes long and thin, attenuate at the apex: sepals oblong, all as well as the similar bract acutely carinate: capsules erect in the spike, cylindraceous-oblong (somewhat over 2 lines long, one-sixteenth inch in diameter), about twice the length of the calyx, circumscissile much below the middle: ovules 6 to 10; seeds 4 to 9, oval-oblong (about a line long), opaque and dull brown, not reticulated. *Gray's Synoptical Flora of N. A.*

† PLANTAGO ERIOPODA, Torr. Perennial; leaves fleshy, broadly lanceolate, 4 to 6 inches long, 1 to 2 inches wide, attenuate at each end, long-petioled, glabrous, entire, 5-nerved; base of the leaves and scape clothed with long dense brown wool; scape 1 foot high, terete, glabrous or pubescent, with a cylindrical spike (3 to 6 inches long) of rather remote perfect flowers; bracts scarious-margined, ciliate; stamens and styles very long; bracts broadly ovate, mostly obtuse; capsules 4- to 5-seeded; seeds not hollowed. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

DODECATHEON, L. AMERICAN COWSLIP.

D. Meadia, L. American Cowslip. Shooting Star. Pride of Ohio.

Lapham. Winona, *Holzinger, Mrs. Terry;* Lake City, *Miss Manning.* Rare. South and west.

TRIENTALIS, L. STAR-FLOWER. CHICKWEED-WINTERGREEN.

T. Americana, Pursh. Star-flower. Chickweed-Wintergreen.

Common through the north half of the state, and south to Minneapolis, *Roberts,* and Saint Paul, *Miss Cathcart;* less frequent farther southeastward, as at lake Pepin, *Miss Manning,* Faribault, *Miss Beane,* and in Blue Earth county, *Leiberg;* absent southwestward.

LYSIMACHIA, Tourn. LOOSESTRIFE.

L. thyrsiflora, L. Tufted Loosestrife.

Frequent throughout the state.

L. stricta, Ait. Loosestrife.

Throughout the state; common northward, and south to Minneapolis; infrequent farther southward.

L. quadrifolia, L. Loosestrife.

Lapham. Dry, sandy ridges, St. Croix river, *Parry;* Lake City, *Mrs. Ray.* Rare. East.

STEIRONEMA, Raf. LOOSESTRIFE.

S. ciliatum, Raf. (Lysimachia ciliata, L.) Loosestrife.

Common, or frequent, throughout the state.

S. lanceolatum, Gray, var. **hybridum,** Gray. (L. lanceolata, Walt., var. hybrida, Gray.) Loosestrife.

Common southward; extending north to Fergus Falls, *Leonard,* and the upper Mississippi river, *Garrison.*

S. longifolium, Gray. (L. longifolia, Pursh.) Loosestrife.

Frequent, often common, in the south half of the state and the Red river valley; extending northeast to the upper Mississippi river, *Garrison.*

GLAUX, Tourn. SEA-MILKWORT.

G. maritima, L. Sea-Milkwort.

Red river prairie (damp places in marshes), *Dawson.* [Between Sheyenne river and Devil's lake, Dakota, *Geyer.*] Northwest.

ANAGALLIS, Tourn. PIMPERNEL.

A. arvensis, L. *Pimpernel.* "*Poor Man's Weather-glass.*"

Martin county, *Gedge.* Rare.

CENTUNCULUS, Dill. CHAFFWEED.

C. minimus, L. Chaffweed.

Pipestone quarry, *Mrs. Bennett.* Rare. Southwest.

[Samolus Valerandi, L., var. Americanus, Gray, will probably be found in Minnesota.]

LENTIBULACEÆ. BLADDERWORT FAMILY.

UTRICULARIA, L. BLADDERWORT.

U. vulgaris, L. Greater Bladderwort.

Frequent throughout the state. (It is sometimes nearly or quite destitute of air-bladders in Hennepin and Blue Earth counties.)

U. minor, L. Smaller Bladderwort.

Also frequent throughout the state.

U. intermedia, Hayne. Bladderwort.

Throughout the state, but infrequent. Traverse des Sioux, Minnesota river, *Parry;* Blue Earth county, *Leiberg;* Minneapolis, *Roberts.* [Emmet county, Iowa (rare), *Cratty;* lake Superior, *Whitney.*]

U. cornuta, Michx. Bladderwort.

Isanti and Morrison counties, *Upham*; Minneapolis, *Simmons.*

PINGUICULA, Tourn. BUTTERWORT.

P. vulgaris, L. Butterwort.

Common north of lake Superior, *Roberts;* Duluth, *Miss Cathcart.* North.

OROBANCHACEÆ. BROOM-RAPE FAMILY.

APHYLLON, Mitchell. NAKED BROOM-RAPE. CANCER-ROOT.

A. Ludovicianum, Gray. (Phelipæa Ludoviciana, Don.) Broom-rape.

Traverse des Sioux, Nicollet county; "found in a singular isolated locality, rooting on an Indian grave." *Parry.* Rare.

A. uniflorum, Gray. One-flowered Cancer-root.

Minneapolis, *Kassube;* Minnehaha falls. *Roberts;* lake Pepin, *Miss Manning.* [Emmet county, Iowa, *Cratty*; lake Superior, *Whitney.*] Rare.

A. fasciculatum, Gray. Naked Broom-rape. Cancer-root.

Bare granite rocks, upper Minnesota river, *Parry;* Lake City, *Miss Manning*; Hesper, Iowa, *Mrs. Carter.* Rare.

SCROPHULARIACEÆ. FIGWORT FAMILY.

VERBASCUM, L. MULLEIN.

V. Thapsus, L. *Common Mullein.*

Common, or frequent, through the east half of the state ; infrequent westward.

V. Blattaria, L. *Moth Mullein.*

Lapham. Lake Pepin, *Miss Manning.* Rare.

LINARIA, Tourn. TOAD-FLAX.

L. Canadensis, Dumont. Wild Toad-Flax.

Plentiful on the prairie about Sandy lake, close north of Minneapolis, *Roberts;* Alexandria, *Mrs. Terry;* upper Mississippi river, *Garrison.* Infrequent.

L. vulgaris, Mill. *Toad-Flax. Butter-and-eggs. Ramsted.*

Becoming a frequent weed, occasionally abundant: upper Mississippi river; Minneapolis; Goodhue, Wabasha, Nicollet and Blue Earth counties.

SCROPHULARIA, Tourn. FIGWORT.

S. nodosa, L., var. **Marilandica**, Gray. Figwort.

Common through the south half of the state; extending north to the upper Mississippi river.

[Collinsia parviflora, Dougl., will probably be found in northern Minnesota.]

CHELONE, L. TURTLE-HEAD. SNAKE-HEAD.

C. glabra, L. Turtle-head. Snake-head. Shell-flower. Balmony.

Common, or frequent, throughout the state, excepting perhaps southwestward.

PENTSTEMON, Mitchell. BEARD-TONGUE. PENTSTEMON.

P. pubescens, Solander. Beard-tongue. Pentstemon.

Common, or frequent, through the southeast and central portions of the state and in the Red river valley, extending northeast to the upper Mississippi river, and to the lake of the Woods (rare), *Dawson*; apparently wanting in Blue Earth county and westward, *Leiberg;* but found in Pipestone county, *Mrs. Bennett.*

P. grandiflorus, Nutt. Large-flowered Pentstemon.

Common from lake Pepin, Saint Paul and Minneapolis, to the upper Mississippi river; and thence frequent westerly to Rock county, *Leiberg*, Pipestone county, *Mrs. Bennett*, and the Red river valley near Glyndon, *Gedge.*

P. acuminatus, Dougl.* Beard-tongue. Pentstemon.

Red river, *Watson* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.* West.

MIMULUS, L. MONKEY-FLOWER.

M. ringens, L. Monkey-flower.

Common, or frequent, throughout the state. (In Blue Earth and Martin counties usually having the angles of the stem very decidedly winged, *Gedge;* so, too, at White Bear, Ramsey county, *Miss Field.*)

M. Jamesii, Torr. & Gray. Monkey-flower.

Throughout the state. Minneapolis (plentiful), Fort Snelling, Stillwater, and lake Pepin; Saint Cloud, and the upper Mississippi river; Beaver creek, Rock county, *Leiberg.*

GRATIOLA, L. HEDGE-HYSSOP.

G. Virginiana, L. Hedge-Hyssop.

Frequent, occasionally common, throughout the state, The most northern localities

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*PENTSTEMON ACUMINATUS, Dougl. Glaucous, 6 to 20 inches high, generally stout and rigid, leafy: leaves coriaceous, somewhat cartilaginous-margined; radical and lowest cauline obovate or oblong; upper cauline from lanceolate to broadly ovate, or the upper cordate-clasping, these mostly acute or acuminate: thyrsus strict, interrupted, leafy below, naked above; the clusters several-flowered, and peduncles and pedicels mostly very short: sepals ovate and acute or lanceolate: corolla lilac or changing to violet; the limb half or two-thirds inch in diameter: sterile filament mostly bearded at the dilated tip: capsule firm-coriaceous and acuminate. *Gray's Synoptical Flora of N. A.*

reported are the St. Louis river, *Mrs. Herrick*, and the Red river (in an open swamp), *Dawson*, who mentions also a variety of this species near Saint Vincent.

[A form which seems to be a distinct variety, or perhaps a species hitherto undescribed, differing much from the ordinary type of G. Virginiana, is reported by *Mr. Leiberg*, with the following description: "Sterile filaments conspicuously tipped with a head; plant rather robust, 8 to 12 inches high, very smooth when dried, but in the growing state covered with a clammy exudation; lower leaves lanceolate, entire, short (half an inch long); upper leaves somewhat clasping, conspicuously 3- to 5-nerved, ovate or broadly lanceolate, acute, mostly sharply toothed, from an inch to one and a half inches long; pedicels mostly longer than the leaves; bractlets under the calyx two, lanceolate, entire or slightly toothed, 5 to 6 lines long, 1 to 1½ lines wide, twice as long and about three times as wide as the sepals; corolla yellowish white, a half inch in length.—Abundant in peaty bogs, Nicollet county. June."]

ILYSANTHES, Raf. FALSE PIMPERNEL.

I. gratioloides, Benth. False Pimpernel.

Fort Snelling, *Roberts;* Blue Earth county (common), *Leiberg;* Emmet county, Iowa (rare), *Cratty*. South.

SYNTHYRIS, Benth. SYNTHYRIS.

S. Houghtoniana, Benth. Synthyris.

Stillwater, *Parry;* Cannon River Falls, *Blake*, *Sandberg*; near Saint Paul, *Roberts*; Chisago and Morrison counties (in the latter common north of Little Falls), *Upham*.

VERONICA, L. SPEEDWELL.

V. Virginica, L. Culver's Physic.

Common through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river.

V. Anagallis, L. Water Speedwell.

Frequent through the south half of the state and in the Red river valley.

V. Americana, Schwein. American Brooklime.

Frequent throughout the state.

V. scutellata, L. Marsh Speedwell.

Throughout the state, but infrequent. Bogs, upper Mississippi river, *Parry;* St. Louis river, *Mrs. Herrick;* Minneapolis, *Juni*, *Kassube*. [Devil's lake, Dakota, *Geyer*.]

[V. serpyllifolia, L., doubtless occurs in this state, but has been overlooked.]

V. peregrina, L. Neckweed. Purslane Speedwell.

Frequent, or common, throughout the state.

V. arvensis, L. *Corn Speedwell.*

Duluth, *Juni;* Heaper, Iowa, *Mrs. Carter*. Infrequent.

BUCHNERA, L. BLUE-HEARTS.

B. Americana, L. Blue-Hearts.

Wabasha, *Gibson*. Rare. Southeast.

GERARDIA, L. GERARDIA.

G. purpurea, L. Purple Gerardia.

Common through the south half of the state; less frequent northward, as at the lake of the Woods, *Dawson*, and in the Red river valley, *Scott*, *Havard*.

G. purpurea, L., var. **paupercula**, Gray.* Purple Gerardia.

Lower Canada to Saskatchewan, and southward from coast of New England to Penn., N. Illinois and Wisconsin, *Gray's Synoptical Flora of N. A.*; apparently the prevailing form of this species in Minnesota.

G. aspera, Dougl. Purple Gerardia.

Common through the west half of the state, abundant in the Red river valley; extending east to lake Pepin, *Miss Manning*.

G. tenuifolia, Vahl. Slender Gerardia.

Common, or frequent, through the south half of the state; also found in the Red river valley, *Scott*, and at Devil's lake, Dakota, *Geyer*; extending northeast to the upper Mississippi river, *Garrison*.

G. tenuifolia, Vahl., var. **asperula**, Gray.† Slender Gerardia.

Collected by *T. J. Hale*, near the St. Croix river, and in Fillmore county.

G. Skinneriana, Wood. (G. setacea, Gray's *Manual*.) Gerardia.

Lapham. Upper Mississippi river, *Garrison*. Rare. South.

G. quercifolia, Pursh. Smooth False Foxglove.

Lapham. Rare. South.

G. grandiflora, Benth. False Foxglove.

Nicollet county, *Aiton*; Saint Paul, *Miss Cathcart*. South.

G. pedicularia, L. Lousewort Foxglove.

Lapham. Minneapolis, *Roberts*; White Bear lake, Ramsey county, *Kelley*; lake Pepin, *Miss Manning*. Southeast.

G. auriculata, Michx. Gerardia.

Blue Earth county, *Leiberg*; Nicollet county, *Aiton*; New Ulm, *Juni*; frequent in Martin county, and in Emmet county, Iowa, *Cratty*. South.

CASTILLEIA, Mutis. PAINTED-CUP.

C. coccinea, Spreng. Scarlet Painted-Cup. Indian Pink. "Bloody Warrior."

Common, often abundant, throughout the wooded portion of the state; less so in the prairie region; rare from Blue Earth county westward, *Leiberg*. Nearly all yellow, at least in some years, upon districts ten to twenty miles in extent, as was observed in Washington and Ramsey counties; elsewhere scarlet, with occasional yellow specimens intermixed.

C. pallida, Kunth, var. **septentrionalis**, Gray. Pale Painted-Cup.

Lapham. Fergus Falls, *Leonard*; Red river valley, *Scott*. [North of lake Superior, *Agassiz*.] Rare. North.

C. sessiliflora, Pursh. Pale Painted-Cup.

Frequent throughout the prairie portion of the state; extending northeast to the upper Mississippi river.

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*GERARDIA PURPUREA, L., var. PAUPERCULA, Gray. A span to a foot high, smoother: stem more simple or with stricter branches: pedicels mainly opposite: flowers decidedly smaller: corolla usually only half inch long, lighter rose-purple; calyx-teeth deltoid-subulate from a broad base, leaving comparatively narrower sinuses, sometimes over half the length of the tube. *Gray's Synoptical Flora of N. A.*

†GERARDIA TENUIFOLIA, Vahl., var. ASPERULA, Gray. Distinguished by Professor Gray, from the typical G. tenuifolia, as follows: Leaves all nearly filiform, the upper side hispidulo-scabrous or asperulous (in the manner of G. aspera): inflorescence more paniculate and with the pedicels all ascending: corolla small, the expanded limb only half an inch in diameter.—Dry and bare hills and bluffs, Missouri to Minnesota, Wisconsin and Michigan. *Botanical Gazette*, vol. iv, p. 153: May, 1879.

ORTHOCARPUS, Nutt. ORTHOCARPUS.

O. luteus, Nutt.* Orthocarpus.

Lapham. North part of the Red river valley (Kittson county), *Upham;* Roseau prairie, *Scott;* Pembina, *Havard.* Northwest.

EUPHRASIA, Tourn. EYEBRIGHT.

E. officinalis, L. Eyebright.

North shore of lake Superior; "abundant everywhere about the edges of mossy thickets, especially on the rocky 'peninsula' at Grand Marais; in bloom the last of July and during August; small and little branched in exposed situations, larger and much branched among other vegetation." *Roberts.* North.

RHINANTHUS, L. YELLOW RATTLE.

R. Crista-galli, L. Yellow Rattle.

Lake Superior, Gray's *Manual;* doubtless in northeastern Minnesota (but probably not in the vicinity of Minneapolis, where it has been reported). North.

PEDICULARIS, Tourn. LOUSEWORT.

P. Canadensis, L. Common Lousewort. Wood Betony.

Common, in many places abundant, throughout the state, excepting perhaps northeastward. Flowers all greenish yellow, with no tinge of purple, upon extensive districts.

P. lanceolata, Michx. Lousewort.

Frequent southeastward; common westward and in the Red river valley.

MELAMPYRUM, Tourn. COW-WHEAT.

M. Americanum, Michx. Cow-Wheat.

Throughout the state; common or frequent northward, rare southward. Pine barrens, St. Croix river, *Parry;* Ramsey county, *Mrs. Terry;* north of lake Superior (common), *Juni, Roberts;* lake of the Woods, *Dawson.*

ACANTHACEÆ. ACANTHUS FAMILY.

RUELLIA, L. RUELLIA.

R. ciliosa, Pursh. Ruellia.

Lake Pepin, *Miss Manning.* Rare. Southeast.

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*ORTHOCARPUS, Nutt. Calyx tubular-campanulate, 4-cleft, or cleft anteriorly and posteriorly and the divisions 2-cleft or parted. Corolla mostly with slender tube; upper lip (galea) little longer and usually much narrower than the inflated 1- to 3-saccate lower one. Stamens 4; the smaller anther-cell sometimes wanting.—Low herbs, almost all annual (W. North American and one Chilian); with mainly alternate entire or 3- to 5-parted and laciniate leaves; the upper passing into bracts of the dense spike and not rarely colored, as also the calyx-lobes; the corolla yellow, or white with purple or rose-color, often much surpassing the calyx. Seeds numerous or rather few. Fl. spring and summer. §2. TRUE ORTHOCARPUS, Benth. Corolla with simply saccate lip inconspicuously or obsoletely 3-toothed, and moderately smaller ovate-triangular galea; its small tip or mucro usually somewhat inflexed or uncinate; stigma small, entire; anthers all 2-celled; seed-coat very loose, costate-reticulated; root annual.

O. LUTEUS, Nutt. Pubescent and hirsute, sometimes viscid; stem strict, a span to a foot high; leaves from linear to lanceolate, occasionally 3-cleft: bracts of the dense spike broader or with more dilated base, completely herbaceous, mostly 3-cleft, about equalling the flowers: corolla golden yellow, less than half inch long, twice or thrice the length of the calyx; tip of galea obtuse and straight. *Gray's Synoptical Flora of N. A.*

VERBENACEÆ. VERVAIN FAMILY.

VERBENA, Tourn. VERVAIN.

V. angustifolia, Michx. Narrow-leaved Vervain.

Stearns county, *Mrs. Blaisdell;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning*. Rare. Southeast.

V. hastata, L. Blue Vervain.

Common throughout the state, excepting far northward, where it is infrequent or rare, both in the Red river valley and about lake Superior; found at the lake of the Woods, *Dawson*.

V. urticæfolia, L. White Vervain. Nettle-leaved Vervain.

Frequency and range like the last.

V. stricta, Vent. Hoary Vervain.

Common, or frequent, on sandy land southward; extending north to the upper Mississippi river, *Houghton*.

V. officinalis, L. *European Vervain.*

Minneapolis, *Herrick*. Rare.

V. bracteosa, Michx. Prostrate Vervain.

Common through the south half of the state; extending north to the upper Mississippi river, *Houghton, Garrison*. (A probable hybrid between this species and V. stricta was found at Minneapolis in 1882. It was procumbent and much branched, much larger and coarser than V. bracteosa, covering a space about three feet in diameter; hirsute; leaves often 3- to 5-cleft; spikes clustered, loosely flowered; bracts inconspicuous, shorter than the calyx; flowers small, blue. *Upham.*)

LIPPIA, L. LIPPIA.

L. lanceolata, Michx. Fog-fruit.

Lake Pepin, *Miss Manning*. Rare. Southeast.

PHRYMA, L. LOPSEED.

P. Leptostachya, L. Lopseed.

Common, or frequent, through the south half of the state; extending north to Todd county, *Upham*, the upper Mississippi river, *Garrison*, and Fergus Falls, *Leonard*.

LABIATÆ. MINT FAMILY.

TEUCRIUM, L. GERMANDER.

T. Canadense, L. American Germander. Wood Sage.

Frequent, occasionally common, through the south half of the state and in the Red river valley to Pembina, *Havard*.

ISANTHUS, Michx.

I. cæruleus, Michx. False Pennyroyal.

Lake City, *Mrs. Ray*; Blue Earth county, *Leiberg*· Minneapolis, *Winchell, Roberts*. South.

MENTHA, Tourn. MINT.

M. viridis, L. *Spearmint.*

Often cultivated, and occasionally spontaneous, escaping from gardens.

M. piperita, L. *Peppermint.*

Occurring like the last.

M. Canadensis, L. Wild Mint.

Common throughout the state.

LYCOPUS, Tourn. WATER HOREHOUND.

L. Virginicus, L. Bugle-weed.

Frequent, especially northward; common north of lake Superior, *Juni, Roberts.*

L. rubellus, Mœnch. (L. Europæus, L., var. integrifolius, Gray.) Water Horehound.

Minneapolis, *Twining, Herrick;* upper Mississippi river, *Garrison;* Baptism river, *Juni.*

L. lucidus, Turcz., var. **Americanus,** Gray.* Water Horehound.

Blue Earth county, *Leiberg;* Bear lakes, Murray county, *Upham.* West.

L. sinuatus, Ell. (L. Europæus, L., var. sinuatus, Gray.) Water Horehound.

Frequent, or common, throughout the state.

PYCNANTHEMUM, Michx. MOUNTAIN MINT. BASIL.

P. lanceolatum, Pursh. Mountain Mint. Basil. "Pennyroyal."

Common, in many districts abundant, on moist land throughout the prairie portion of the state.

P. linifolium, Pursh. Mountain Mint. Basil.

Blue Earth county, *Leiberg.* South.

CALAMINTHA, Tourn., Mœnch. CALAMINT.

C. Nuttallii, Benth. (C. glabella, Benth., var. Nuttallii, Gray.) Calamint.

Falls of St. Anthony, *Wood's Class-Book.* Infrequent. East.

C. Clinopodium, Benth. Basil.

Stearns county, *Garrison.* Infrequent.

HEDEOMA, Pers. MOCK PENNYROYAL.

H. pulegioides, Pers. American Pennyroyal.

Upper Mississippi river, *Garrison;* lake Pepin, *Miss Manning.* Rare. South.

H. hispida, Pursh. Mock Pennyroyal.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river, *Garrison.*

MONARDA, L. HORSE-MINT.

M. fistulosa, L. Wild Bergamot.

Throughout the state: frequent northeastward; common, often abundant, southward and in the Red river valley.

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*LYCOPUS LUCIDUS, Turcz. Stem stout (2 to 3 feet high), erect, acute-angled at top; leaves lanceolate or oblong-lanceolate (2 to 4 inches long), acute or acuminate, with large and very sharp serrations, the base obtuse, or occasionally acute, subsessile; calyx-teeth alternate, subulate.—Var. AMERICANUS, Gray. Leaves barely shining on both sides, often hairy-pubescent; stem generally hairy; calyx-teeth small and rigid. *Gray's Revision of Lycopus, Proc. Amer. Acad.*, 1870.

M. punctata, L. Horse-Mint.

Upper Mississippi river, *Houghton;* Stearns county, *Mrs. Blaisdell;* Nicollet county, *Aiton*; lake Pepin, *Miss Manning.* Rare. Southeast.

BLEPHILIA, Raf. BLEPHILIA.

B. ciliata, Raf. Blephilia.

Lapham. Rare. Southeast.

B. hirsuta, Benth. Blephilia.

Lapham. Infrequent. Southeast.

LOPHANTHUS, Benth. GIANT HYSSOP.

L. nepetoides, Benth. Giant Hyssop.

Falls of the St. Croix, *Parry;* Lac qui Parle county, *Upham.* South.

L. scrophulariæfolius, Benth. Giant Hyssop.

Frequent southward; extending north to the upper Mississippi river, *Houghton.*

L. anisatus, Benth. Anise Hyssop.

Common, or frequent through the south half of the state; abundant in the Red river valley; extending northeast to the upper Mississippi, *Houghton*, and Rainy Lake river, *Keating.* "All three of the above species are found side by side at the Falls of the St. Croix." *Parry.*

NEPETA, L. CAT-MINT.

N. Cataria, L. *Catnip.*

Frequent throughout the state.

N. Glechoma, Benth. *Ground Ivy. Gill.*

Occasionally adventive: Todd county, *Upham;* Minneapolis (frequent), *Roberts;* Mankato, *Leiberg;* Lake City, *Miss Manning;* Emmet county, Iowa (rare), *Cratty.*

DRACOCEPHALUM, Tourn. DRAGON-HEAD.

D. parviflorum, Nutt. Dragon-head.

Throughout the state: frequent northward; rare southward.

PHYSOSTEGIA, Benth. FALSE DRAGON-HEAD. LION'S-HEART.

P. Virginiana, Benth. False Dragon-head. Lion's-heart.

Frequent through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river, *Parry.*

BRUNELLA, Tourn. SELF-HEAL. HEAL-ALL.

B. vulgaris, L. Self-heal. Heal-all.

Throughout the state: common northward; frequent southward.

SCUTELLARIA, L. SKULLCAP.

S. versicolor, Nutt. Skullcap.

Lapham. Shore of lake Pepin, in Wisconsin, *Miss Manning.* South.

S. parvula, Michx. Skullcap.

Frequent through the south half of the state and north to the upper Mississippi river.

S. galericulata, L. Skullcap.

Common, or frequent, throughout the state.

S. lateriflora, L. Mad-dog Skullcap.

Commonness and range like the last.

MARRUBIUM, Tourn. HOREHOUND.

M. vulgare, L. *Horehound.*

Lake Pepin, *Miss Manning*. Infrequent.

GALEOPSIS, L. HEMP-NETTLE.

G. Tetrahit, L. *Common Hemp-Nettle.*

Abundant north of lake Superior; infrequent southward. *Mr. Roberts* describes it on the north shore of lake Superior as "very common, growing on the shingle especially; corolla almost universally white, marked with yellow in the throat; rarely purple."

STACHYS, Tourn. HEDGE-NETTLE. WOUNDWORT.

S. palustris, L. Hedge-Nettle. Woundwort.

Abundant on moist ground and margins of sloughs throughout the state; in many districts southwestward persisting as a weed in wheat-fields. (The tube of the corolla is abruptly constricted on the front side near its base, and within at that point bears short white hair. Floral leaves small, but much exceeding the sessile calyx.)

S. aspera, Michx. (S. palustris, L., var. aspera, Gray.) Hedge-Nettle. Woundwort.

Common north of lake Superior at Little Marais and Palisades, *Roberts;* Pembina, *Chickering*, *Scott;* Stearns county. *Garrison;* Minneapolis, *Twining*, *Kassube;* Blue Earth county, *Leiberg.*

LEONURUS, L. MOTHERWORT.

L. Cardiaca, L. *Common Motherwort.*

Becoming frequent southward: Minneapolis; Saint Paul; Stillwater; lake Pepin; Fillmore, Blue Earth and Martin counties.

LAMIUM, Tourn. DEAD-NETTLE.

L. amplexicaule, L. *Dead-Nettle.*

Excelsior, near Minneapolis, *Mrs. Herrick;* probably also at Duluth. This is likely to become a frequent weed.

BORRAGINACEÆ. BORAGE FAMILY.

SYMPHYTUM, Tourn. COMFREY.

S. officinale, L. *Comfrey.*

Escaped from cultivation: Minneapolis, *W. H. Hatch;* Goodhue county, *Sandberg*. Infrequent.

ONOSMODIUM, Michx. FALSE GROMWELL.

O. Carolinianum, DC. False Gromwell.

Frequent, occasionally common, through the south half of the state

O. Carolinianum, DC., var. **molle,** Gray. (O. molle, Michx.) False Gromwell.

Winona county, *Holzinger;* Spring Valley, Fillmore county, *Dr. W. E. Leonard;* Scott county, *Winchell;* Nicollet county, *Aiton;* Blue Earth county, *Leiberg;* Fergus Falls, *Dr. H. C. Leonard*; Worthington (rare), *Foote.* South and west.

LITHOSPERMUM, Tourn. GROMWELL. PUCCOON.

[*L. arvense,* L., may be expected. It is reported in Michigan as a bad weed in wheat-fields.]

L. angustifolium, Michx. Narrow-leaved Gromwell.

Frequent southward and in the Red river valley; extending northeast to the upper Mississippi river. (The early-flowering state of this species, with the tube of the corolla much elongated, is described in Gray's *Manual* under the name L. longiflorum, Spreng.)

L. officinale, L. *Common Gromwell.*

Minneapolis, *Roberts, Herrick;* Brockway, Stearns county, *Miss Campbell.* Rare.

L. latifolium, Michx. Broad-leaved Gromwell.

Isanti county, *Upham;* Saint Paul, *Miss Cathcart;* near Meeker's island, Minneapolis, *Kassube;* Chaska, Carver county, *Juni;* Blue Earth county, *Leiberg;* Martin county (rare), *Cratty.* South.

L. hirtum, Lehm. Hairy Puccoon.

Common, often abundant, on sandy land in the south half of the state; extending north at least to Fergus Falls, *Leonard.*

L. canescens, Lehm. Hairy Puccoon or Alkanet. "Indian Paint."

Abundant, or common, through the south half of the state, and in the Red river valley; extending northeast to the upper Mississippi river. The red juice of the root is used by the Indians to paint their faces and for other purposes in dyeing.

[For L longiflorum, Spreng, see L. angustifolium, Michx., above.]

MERTENSIA, Roth. SMOOTH LUNGWORT.

M. Virginica, DC. Virginian Cowslip or Lungwort. "Blue Bells."

Lapham. Rochester, Olmsted county, *Miss Beane;* Le Roy, Mower county, *Miss Bixby.* Southeast.

M. paniculata, Don. Smooth Lungwort.

Common on the north shore of lake Superior, *Juni, Roberts;* St. Louis river, *Mrs. Herrick,* "The flower-buds pink, turning blue as they open, thus giving the flowering plant a showy, variegated appearance. Still blooming in August." *Roberts.*

MYOSOTIS, L. SCORPION-GRASS. FORGET-ME-NOT.

M. arvensis, Hoffm. Forget-me-not.

Minneapolis (quite surely this species), *Herrick.* Rare.

M. verna, Nutt. Forget-me-not.

Pipestone county, *Mrs. Bennett.* Rare.

ECHINOSPERMUM, Swartz. STICKSEED. BUR-SEED.

E. floribundum, Lehm.* Stickseed. Bur-seed.

Red river near Saint Vincent, *Dawson.* West.

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*ECHINOSPERMUM FLORIBUNDUM, Lehm. Rather strict, two feet or more high, or sometimes smaller: leaves from oblong- to linear-lanceolate; the lowest tapering into

E. deflexum, Lehm.* Stickseed. Bur-seed.

Red river valley at Pembina, *Havard.* Northwest.

E. Lappula, Lehm. *Stickseed. Bur-seed. "Stick-tight."*

Common, often abundant, through the south half of the state; less frequent in the Red river valley and the region of lake Superior (reported at Duluth, *Juni*, and in the vicinity of Saint Vincent, abundant, *Dawson*).

E. Redowskii, Lehm., var. **occidentale,** Watson. Stickseed. Bur-seed. "Stick-tight."

Frequency and range nearly like the last; but probably absent northeastward. (Procumbent and ascending, six to twelve inches high.)—The American plant is less strict, at length diffuse, and the tubercles or scabrosities of the nutlet are sharp instead of blunt or roundish, as in the Asiatic plant. *Gray's Synoptical Flora of N. A.*

E. Virginicum, Lehm. (Cynoglossum Morrisoni, DC.) Beggar's Lice. Stickseed. Bur-seed. "Stick-tight."

Common, or frequent, through the south half of the state; rare or less frequent northward.

CYNOGLOSSUM, Tourn. HOUND'S-TONGUE.

C. officinale, L. *Hound's-Tongue.*

Becoming a frequent weed: lake Pepin, *Miss Manning;* Hastings, *Leonard*, and Mendota, Dakota county, *Kassube;* Nicollet county, *Aiton;* Jordan, Scott county, *Juni;* Stearns county, *Garrison, Campbell.*

C. Virginicum, L. Wild Comfrey.

Goodhue county, *Sandberg*; Stearns county, *Upham;* St. Louis river, *Mrs. Herrick*. East and north.

ASPERUGO, Tourn. GERMAN MUDWORT.

A. procumbens, L.† *German Mudwort.*

Adventive, but scarcely established, at Pipestone City, *Mrs. Bennett.* Rare.

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margined petioles: racemes numerous, commonly geminate and in fruit rather strict: nutlets with elongated triangular back naked (2 lines long), merely scabrous; and the margin armed with a close row of flat subulate prickles, their bases often confluent; scar smaller and narrowly ovate. Limb of corolla varying from 2 to 5 lines in diameter. *Gray's Synoptical Flora of N. A.*

*ECHINOSPERMUM DEFLEXUM, Lehm. Diffusely branched, a foot or so high: leaves from oblong to lanceolate: racemes lax, loosely paniculate: flowers soon sparse, smaller than in the preceding: nutlets smaller, and the mostly naked back (a line long) broader. . . . . . Habit intermediate between the preceding and E. Virginicum, Lehm.; the American specimens having occasionally some few prickles developed from the rough-granulate dorsal face of the nutlets. Fruit as well as flowers about half the size of that of E. floribundum. *Gray's Synoptical Flora of N. A.*

†ASPERUGO, Tourn. Calyx when in flower nearly regular, deeply 5-cleft, in fruit 2-lobed, with the lobes valvate, closed, flattish, palmately laciniate, the one 6- and the other 7-toothed. Corolla funnelshaped-salvershaped; the throat closed by 5 obtuse scales; limb concave, 5-lobed. Stamens included. Nucules laterally compressed, nearly smooth with raised dots, attached by their narrow inner edge to the conical receptacle. A rough herb with fragile juicy stems, and small axillary purplish-blue flowers. Calyx much enlarged and veined in fruit, somewhat like the perianth of the female flowers of the genus Atriplex.

A. procumbens, L. The only known species. Annual; stem 1 to 3 feet long, procumbent or trailing, succulent, brittle, angular, thinly studded with reflexed prickles,

HYDROPHYLLACEÆ. WATERLEAF FAMILY.

HYDROPHYLLUM, Tourn. WATERLEAF.

H. Virginicum, L. Waterleaf.

Common, occasionally abundant, through the south half of the state; extending north at least to Morrison county (plentiful), *Upham*, and Clay county in the Red river valley, *Gedge*.

H. appendiculatum, Michx. Waterleaf.

Lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg*. South.

ELLISIA, L. ELLISIA.

E. Nyctelea, L. (Including the slender form, E. ambigua, Nutt., which prevails here.) Ellisia.

Frequent through the south half of the state and in the Red river valley.

PHACELIA, Juss. PHACELIA.

P. Purshii, Buckley. Phacelia.

Gray's *Synoptical Flora of N. A.*; Goodhue county, *Sandberg*. Rare. Southeast.

P. Franklinii, Gray. Phacelia.

Shores of lake Superior, especially on Isle Royale, Gray's *Manual*; abundant at Port Arthur, *Macoun*; surely also in northern Minnesota.

POLEMONIACEÆ. POLEMONIUM FAMILY.

POLEMONIUM, Tourn. GREEK VALERIAN.

P. reptans, L. Greek Valerian.

Hesper, Iowa, adjoining Fillmore county (common), *Mrs. Carter*; Winona, *Holzinger*; lake Pepin, *Miss Manning*; Cannon River Falls, *Blake*, *Sandberg*; extending northwest to New Ulm, *Leiberg*, and Alexandria, *Mrs. Terry*. Infrequent. Southeast.

PHLOX, L. PHLOX.

P. maculata, L. Wild Sweet William.

Northfield, Rice county, *Chaney*; Dakota county, *Winchell*, *Upham*; Minneapolis, *Herrick* South.

P. glaberrima, L. Phlox.

St. Croix Falls, *Miss Field*; New Ulm, *Juni*; upper Mississippi river, *Garrison*. Infrequent. South.

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by which they readily adhere to the clothes of passers-by and to the coats of animals. Leaves oblanceolate, subobtuse, the lower ones narrowed into winged petioles and slightly decurrent, those on the upper part of the stem scarcely stalked, nearly opposite, or 3 or 4 in a whorl, more or less clothed with hairs, many of which are hooked-pointed. Peduncles very short, at first erect, afterwards recurved, 1-flowered. Corolla ⅙ inch across, dull purplish blue. Calyx in fruit ½ inch long, dorsally compressed, of 2 palmately laciniate valves, adpressed to each other, with a prominent network of veins, sparingly ciliated and clothed with bristly hairs. Nucules yellowish-gray, one-fifth inch long, thickly studded with smooth white scale-like patches. *Sowerby's English Botany*, vol. vii.

P. pilosa, L. Hairy Phlox.

Common throughout the prairie portion of the state; extending northeast to the upper Mississippi river, *Houghton*, *Garrison*.

P. divaricata, L. Phlox.

Frequent, or common, southward; extending north to Minneapolis (common), *Roberts*, and Redwood Falls, *Pemberton*. [The var. Laphamii, Wood, occurs at Minnehaha falls (plentiful), *Roberts*, and is also common at Hesper, Iowa, *Mrs. Carter*.]

COLLOMIA, Nutt. COLLOMIA.

C. linearis, Nutt.* Collomia.

Pipestone county, *Mrs. Bennett*. [Upper Missouri river, *Geyer*.] West.

CONVOLVULACEÆ. CONVOLVULUS FAMILY.

CONVOLVULUS, L BINDWEED.

C. sepium, L. (Calystegia sepium, R. Br.) Hedge Bindweed. Bracted Bindweed.

Common through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river; also, St. Louis river, *Mrs. Herrick*, and probably throughout Minnesota.

C. sepium, L., var. **repens**, Gray.† (var. pubescens, Gray, in *Manual*.)

Clay county, in the Red river valley, *Gedge*.

C. spithamæus, L. (Calystegia spithamæa, Pursh.) Bracted Bindweed.

Throughout the state, but infrequent. Winona county, *Holzinger*; lake Pepin, *Miss Manning*; Dellwood, White Bear lake, Ramsey county, *Kelley*; near Minneapolis (rare), *Kassube*; Stearns county, *Mrs. Blaisdell*; St. Louis river, *Mrs. Herrick*; Red river prairie (rare), *Dawson*; Pembina (in woods), *Chickering*.

CUSCUTA, Tourn. DODDER.

C. tenuiflora, Engelm. Dodder.

Lapham. Blue Earth county, *Leiberg*, determined by *Watson*. South.

C. chlorocarpa, Engelm. Dodder.

Minneapolis, *Kassube*; Blue Earth county, *Leiberg*. South.

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*COLLOMIA, Nutt. Corolla tubular-funnelform or salverform with a more or less dilated throat. Filaments slender, unequally inserted, usually protruded. Ovules solitary, few or many in each cell. Seed-coat developing mucilage and projecting numerous spiral threads (spiricles) when wetted (except in C. gracilis). Annuals or some biennials, with alternate leaves (or only the lower ones opposite), which are usually pinnately incised or divided, and with clustered or sometimes scattered flowers.

C. LINEARIS, Nutt. Annual, more or less viscid-pubescent, becoming glabrate below, glandular above; stems erect, simple or branching, 6 to 18 inches high; leaves sessile, lanceolate, very entire; heads crowded; lobes of the calyx triangular-lanceolate, acute; corolla light blue or nearly white, 6 lines long, slender, but little enlarged at the throat, the limb small; ovules solitary; seeds with very numerous spiricles. *Porter and Coulter's Flora of Colorado*, and *Botany of King's Report*, following Gray's *Revision of N. A. Polemoniaceæ*, *Proc. Amer. Acad.*, 1870, vol. viii.

†CONVOLVULUS SEPIUM, L., var. REPENS, Gray. Corolla from almost white to rose-color: bracts from very obtuse to acute: herbage from minutely to tomentose-pubescent: sterile and sometimes flowering stems extensively prostrate: leaves more narrowly sagittate or cordate, the basal lobes commonly obtuse or rounded and entire. *Gray's Synoptical Flora of N. A.*

C. Gronovii, Willd. Dodder.

Common, or frequent, through the south half of the state and in the Red river valley.

C. Gronovii, Willd., var. **latiflora,** Engelm. Dodder.

Doubtless in this state; as it occurs at Hesper, in the north edge of Iowa (on Impatiens fulva), *Mrs. Carter, Arthur*. [A form with flowers of more delicate texture, and shorter tube and longer lobes to the corolla. *Gray's Synoptical Flora of N. A.*]

C. glomerata, Choisy. Dodder.

Frequent, or common, through the south part of the state; extending north to Stearns county, *Campbell*, and Redwood Falls, *Miss Butler*.

SOLANACEÆ. NIGHTSHADE FAMILY.

SOLANUM, Tourn. NIGHTSHADE.

S. Dulcamara, L. *Bittersweet.*

Stillwater, *Miss Field*; Lake City, *Mrs. Ray*. Infrequent.

S. nigrum, L. Common Nightshade. Black Nightshade.

Common through the south half of the state, especially southwestward, where the berries are often used for pies and sauce. Indigenous; also cosmopolitan.

PHYSALIS, L. GROUND CHERRY.

P. grandiflora, Hook. Ground Cherry.

Upper Mississippi river, *Garrison;* Stearns county, *Mrs. Blaisdell;* St. Louis river, *Mrs. Herrick*. North.

P. Philadelphica, Lam. Ground Cherry.

Lake Pepin, *Miss Manning*; Blue Earth county, *Leiberg*; Redwood Falls, *Pemberton*. South.

P. angulata, L. Ground Cherry.

Lapham. Minneapolis, *Twining*, *Simmons*. Rare. South.

P. pubescens, L. Ground Cherry.

Frequent, or common, in the south part of the state; extending west at least to Worthington, Nobles county (common), *Foote*, and north to New Ulm and Anoka county, *Juni*, and Stearns county, *Campbell*.

P. Virginiana, Mill. (P. viscosa, in Gray's *Manual.*) Ground Cherry.

Frequent southward; extending north to the upper Mississippi river, *Garrison*. [North of lake Superior, *Agassiz;* Pembina mountain, *Havard*.]

P. Virginiana, Mill., var. **ambigua,** Gray. Ground Cherry.

A coarse and very villous form with anthers violet!—Wisconsin (*Lapham*) to Saskatchewan, *Bourgeau*, *Drummond*, &c., *Gray's Synoptical Flora of N. A.*; therefore doubtless in Minnesota.

P. lanceolata, Michx. (P. Pennsylvanica, in *Manual.*) Ground Cherry.

Common, or frequent, through the south half of the state and in the Red river valley; extending northeast to Itasca lake, *Houghton*.

NICANDRA, Adans. APPLE OF PERU.

N. physaloides, Gærtn. *Apple of Peru.*

Adventive, Minneapolis, *Williams*, *Roberts*. Infrequent.

LYCIUM, L. MATRIMONY-VINE.

L. vulgare, Dunal. *Matrimony-Vine.*

Adventive, Minneapolis, *Juni, Roberts.* Infrequent.

DATURA, L. JAMESTOWN-WEED. THORN-APPLE.

D. Stramonium, L. *Common Stramonium* or *Thorn-Apple.*

Stearns county, *Campbell*, Minneapolis, *Roberts;* Goodhue county, *Sandberg;* Blue Earth county, *Leiberg.* Infrequent. South.

D. Tatula, L. *Purple Thorn-Apple.*

Saint Paul, *Miss Cathcart;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning.* Rare. South.

NICOTIANA, Tourn. TOBACCO.

N. rustica, L. *Wild Tobacco.*

Near Clotho, Todd county, *Upham*; "a relic of cultivation by the Indians." Rare.

GENTIANACEÆ. GENTIAN FAMILY.

HALENIA, Borkh. SPURRED GENTIAN.

H. deflexa, Griseb. Spurred Gentian.

Common north of lake Superior, *Juni, Roberts;* lake of the Woods, *Dawson.* North.

GENTIANA, Tourn. GENTIAN.

G. Amarella, L., var. **acuta**, Hook. f.* Gentian.

Red river valley near Saint Vincent, *Scott;* determined by *Watson.* Northwest.

G. quinqueflora, Lam., var. **occidentalis**, Gray. Five-flowered Gentian.

Frequent, or occasional, through the south part of the state; extending north to Saint Paul and White Bear lake, *Mrs. Terry*, Stillwater, *Miss Field*, and the upper Mississippi river, *Garrison.* [Common at Hesper, *Mrs. Carter*, and in Emmet county, Iowa, *Cratty.*

G. crinita, Frœl. Fringed Gentian.

Common, or frequent, throughout the state.

G. serrata, Gunner. (G. detonsa, in *Manual.*) Smaller Fringed Gentian.

Also common throughout the state. This and the preceding grow together, and in many places are very abundant locally.

G. alba, Muhl. Whitish Gentian.

Throughout the state, but infrequent. Hesper, *Mrs. Carter;* Winona, *Holzinger;* Cannon River Falls, *Blake, Sandberg;* Faribault, *Miss Beane;* Saint Paul, *Miss Cathcart;*

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*GENTIANA AMARELLA. L. From 2 to 20 inches high: leaves from lanceolate to narrowly oblong, or the lowest obovate-spatulate: inflorescence disposed to be racemiform: calyx 5-cleft (or rarely 4-cleft) below the middle; the lobes lanceolate or linear, equal or one or two of them longer, all shorter than the mostly blue corolla: the latter (funnelform, with entire lobes) half inch or more long; its lobes oblong, obtuse or becoming acute (with setaceous-fimbriate crown on their base): capsule sessile.—Var. ACUTA. Hook. f. Calyx almost 5-parted; crown usually of fewer and sometimes very few setæ. *Gray's Synoptical Flora of N. A.*

Minneapolis, *Roberts;* St. Croix Falls, *Miss Field;* New Ulm, *Juni;* Stearns county, *Campbell;* Roseau river, *Scott.*

G. Andrewsii, Griseb. Closed Gentian.

Frequent through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river, *Geyer. Garrison.*

G. Saponaria, L. Soapwort Gentian.

Lapham. Cannon river. *Geyer;* Anoka county, *Juni;* Pembina, *Havard.* Infrequent. South and west.

G. linearis, Frœl., var. **lanceolata,** Gray.* Gentian.

Minnesota and along lake Superior, Gray's *Synoptical Flora of N. A.;* frequent on prairies, Blue Earth county, *Leiberg.*

G. puberula, Michx. Gentian.

Common, or frequent, through the south half of the state and in the Red river valley (common northward to Ada, Norman county, *Upham,* and infrequent to the vicinity of Saint Vincent, *Scott*).

G. affinis, Griseb.† Gentian.

Lapham. Red river, *Watson* in King's *Report;* near Saint Vincent, *Scott,* determined by *Watson.* West.

MENYANTHES, Tourn. BUCKBEAN.

M. trifoliata, L. Buckbean.

Common throughout the state.

LIMNANTHEMUM, Gmelin. FLOATING HEART.

L. lacunosum, Griseb. Floating Heart.

In a lake near Alexandria, Douglas county, *Mrs. Terry.* Rare.

APOCYNACEÆ. DOGBANE FAMILY.

APOCYNUM, Tourn. DOGBANE. INDIAN HEMP.

A. androsæmifolium, L. Spreading Dogbane.

Common throughout the state.

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*GENTIANA LINEARIS, Frœl. (G. Saponaria, L., var. linearis, Griseb.) Smooth throughout: stem slender and strict, a foot or two high: leaves linear or narrowly lanceolate, 1½ to 3 inches long, 2 to 5 lines wide, and with somewhat narrowed base: flowers 1 to 5 in the terminal involucrate cluster, and often solitary in one or two axils below: calyx-lobes linear or lanceolate, shorter than the tube: corolla blue, an inch or more long, narrow-funnelform; the erect lobes roundish-ovate and obtuse, 2 lines long, a little longer than the triangular acute and entire or slightly 1- to 2-toothed appendages.—Var. LANCEOLATA. Leaves lanceolate, or the upper and involucrate ones almost ovate-lanceolate (1 or 2 inches long and even half inch wide): appendages of the sinuses of the corolla sometimes very short and broad. . . . Approaches narrow-leaved forms of G. alba. *Gray's Synoptical Flora of N. A.*

†GENTIANA AFFINIS, Griseb. Stems clustered, a span to a foot high, mostly ascending: leaves from oblong to lanceolate or linear: flowers from numerous and thyrsoid-racemose to few or rarely almost solitary: bracts lanceolate or linear: calyx-lobes linear or subulate, unequal and variable, the longest rarely equalling the tube, the shorter sometimes minute: corolla an inch or less long, rather narrowly funnelform; its lobes ovate, acutish or mucronulate-pointed, spreading. *Gray's Synoptical Flora of N. A.*

A. cannabinum, L. Indian Hemp.

Also common throughout the state. (Polymorphous; the var. glaberrimum, DC., has been noted in Faribault county, *Upham;* and var. hypericifolium, Gray, at lake Minnetonka, *Roberts*, St. Louis river, *Mrs. Herrick*, and Pembina, *Havard;* var. pubescens, DC., probably also occurs here; but intermediate forms are found, "rendering useless any sub-specific names."

ASCLEPIADACEÆ. MILKWEED FAMILY.

ASCLEPIAS, L, MILKWEED. SILKWEED.

A. speciosa, Torr.* Milkweed. Silkweed.

Red river valley, in Clay county (frequent on portions of the prairie which are intermediate between wet and dry), *Upham;* Big Stone county, *Campbell*, determined by *Prof. Asa Gray;* extending east to the central part of Minnesota, *Rev. E. L. Greene*, and Martin county, *Gedge*, *Leiberg*. [Frequent in Emmet county, Iowa (sometimes troublesome in grain-fields, like A. Cornuti elsewhere), *Cratty*.] West.

A. Cornuti, Decaisne. Common Milkweed or Silkweed.

Common throughout the state, excepting perhaps northeastward.

A. Sullivantii, Engelm. Sullivant's Milkweed.

Common, or frequent, across the south part of the state; extending north to Blue Earth county, *Gedge*, Brown county, *Juni*, wet prairies of central Minnesota, *Rev. E. L. Greene*, and in the Red river valley at least to Clay county (frequent), *Gedge*.

A. phytolaccoides, Pursh. Poke-Milkweed.

St. Croix river, *Parry;* lake Pepin, *Miss Manning;* Minneapolis, *Herrick*, *Hatch;* Stearns county, *Upham;* Detroit, Becker county, *Gedge*. Infrequent. South.

A. purpurascens, L. Purple Milkweed.

Lake Pepin, *Miss Manning;* Stillwater, *Miss Field;* Hennepin county, *Herrick*, *Hatch;* upper Mississippi river, *Garrison*. Infrequent. South.

A. ovalifolia, Decaisne. Milkweed.

Frequent throughout the prairie region of the state: common in Benton, Stearns and Todd counties (in oak openings and prairies), *Upham;* the most common species of this genus in the Red river valley, *Gedge*.

A. quadrifolia, L. Four-leaved Milkweed.

Shores of lake Pepin, both in Minnesota and Wisconsin, *Miss Manning*. Rare. South.

A. incarnata, L. Swamp Milkweed.

Common throughout the state.

A. incarnata, L., var. **pulchra**, Pers. Swamp Milkweed.

Minneapolis, *Kassube*.

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*ASCLEPIAS SPECIOSA, Torr. Finely canescent-tomentose, rarely glabrate with age: leaves from subcordate-oval to oblong, thickish: peduncles shorter than the leaves: pedicels of the many-flowered dense umbel and the calyx densely tomentose: flowers purplish, large: corolla-lobes ovate-oblong, 4 or 5 lines long: hoods 5 or 6 lines long, spreading, the dilated body and its short inflexed horn not surpassing the anthers, but the center of its truncate summit abruptly produced into a lanceolate-ligulate thrice longer termination: column hardly any: wings of the anthers notched and obscurely corniculate at base.—Follicles echinate with soft spinous processes and densely tomentose, large (3 to 5 inches long) and ventricose, ovate and acuminate, arrect on deflexed pedicels: leaves large and broad, short-petioled, transversely veined: stems stout and simple, 2 to 5 feet high. *Gray's Synoptical Flora of N. A.*

A. obtusifolia, Michx. Milkweed.

Lapham. South.

A. tuberosa, L. Butterfly-weed. Pleurisy-root.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river, *Garrison*, and Fergus Falls, *Leonard;* not observed in Clay county, *Gedge.*

A. verticillata, L. Whorled Milkweed.

Frequent southeastward; extending north to Otter Tail county, *Upham*, Clay county (common), *Gedge*, and Pembina, *Chickering.*

ACERATES, Ell. Green Milkweed.

A. viridiflora, Ell. Green Milkweed.

Occasional through the south half of the state and in the Red river valley.

A. viridiflora, Ell., var. **lanceolata,** Gray. Green Milkweed.

Blue Earth county (frequent), *Leiberg;* Clay county, Red river valley, *Gedge.* [With lanceolate leaves 2½ to 4 inches long. *Gray's Synoptical Flora of N. A.*]

A. viridiflora, Ell., var. **linearis,** Gray. Green Milkweed.

Clay county, *Gedge.* West. [With elongated linear leaves and low stems: umbels often solitary.—Winnipeg Valley to New Mexico. *Gray's Synoptical Flora of N. A.*]

A. lanuginosa, Decaisne. Green Milkweed.

Winona county, *Holzinger;* Blue Earth county, *Leiberg;* Minneapolis, *Juni*, *Roberts;* Redwood Falls, *Pemberton;* Clay county, Red river valley, *Gedge.* (Specimens with some of the leaves having two equally prominent midribs and the end bifid were collected in Clay county by *Prof. Gedge.*) South and west.

A. longifolia, Ell. Green Milkweed.

Freeborn county, *Upham;* Cannon River Falls, *Blake*, *Sandberg;* frequent in Martin county, and in Emmet county, Iowa, *Cratty;* Stearns county, *Mrs. Blaisdell;* upper Mississippi river, *Garrison.* South.

OLEACEÆ. Olive Family.

FRAXINUS, Tourn. Ash.

F. Americana, L. White Ash.

Frequent, often common, throughout the state, excepting far northward. The white and black ash are well known as valuable timber trees.

F. pubescens, Lam. Red Ash.

Frequent from lake Pepin, *Miss Manning*, to Stearns and Todd counties and Sand Hill river, *Upham;* the White Earth reservation, *Garrison;* reaching its northern limit on Rainy river, *Richardson.*

F. viridis, Michx. f. Green Ash.

Common, or frequent, throughout the state; extending north at least to Rainy river and the lake of the Woods, and common along the Red river in Manitoba, *Bell;* the most common species of ash in Iowa, *Arthur.*

F. sambucifolia, Lam. Black Ash.

Frequent, occasionally plentiful, throughout the state, excepting perhaps southwestward. [Its northwestern limit reaches the southern part of lake Winnipeg, and thence extends southward along the east side of Red river, *Bell.*]

F. quadrangulata, Michx. Blue Ash.

Upper Mississippi river, *Garrison;* near the Rainy lake valley, *Clark.* Rare.

ARISTOLOCHIACEÆ. BIRTHWORT FAMILY.

ASARUM, Tourn. ASARABACCA. WILD GINGER.

A. Canadense, L. Asarabacca. Wild Ginger.

Common, or frequent, throughout the state.

ARISTOLOCHIA, Tourn. BIRTHWORT.

A. Sipho, L'Her. Pipe-Vine. Dutchman's Pipe.

Fillmore, Houston and Ramsey counties, *Winchell*; Rice county, *Sperry*; lake Pepin, *Miss Manning*. Southeast.

NYCTAGINACEÆ. FOUR-O'CLOCK FAMILY.

OXYBAPHUS, Vahl. OXYBAPHUS.

O. nyctagineus, Sweet. Oxybaphus.

Common, or frequent, through the south half of the state; extending north to the upper Mississippi river, *Parry*, *Garrison*, and Sand Hill river, *Upham*; also found at the lake of the Woods (sandy ridges of southern shore), *Dawson*.

O. hirsutus, Sweet. Oxybaphus.

Frequent southward; extending north to Minneapolis and Big Stone lake, *Upham*, and to Pembina, *Havard*. South and west. [One foot high, hirsute throughout; leaves lanceolate, thick, the lower short-petioled: fruit of O. nyctagineus. *Botany of King's Expl. of the Fortieth Parallel.*]

O. angustifolius, Sweet. Oxybaphus.

Frequent through the south half of the state. Southwest. [One to six feet high, glabrous, except the peduncles and involucres; leaves linear. *Botany of King's Expl. of the Fortieth Parallel*. In all these species the fruit is pubescent, and the involucre always 3- to 5-flowered.]

PHYTOLACCACEÆ. POKEWEED FAMILY.

PHYTOLACCA, Tourn. POKEWEED.

P. decandra, L. Garget. Poke. Scoke. Pigeon-Berry.

Throughout the south half of the state, but infrequent or rare. Blue Earth county, *Leiberg*; Minneapolis, *A. W. Jones*; upper Mississippi river, *Garrison*.

CHENOPODIACEÆ. GOOSEFOOT FAMILY.

CYCLOLOMA, Moquin. WINGED PIGWEED.

C. platyphyllum, Moquin. Winged Pigweed.

Beach at northwest side of Mille Lacs (plentiful), and north end of Long lake, Crow Wing county, *Upham*.

CHENOPODIUM, Tourn. (Including BLITUM, Tourn.) GOOSEFOOT. PIGWEED.

C. album, L. *Lamb's-Quarters. Pigweed.*

A common weed in waste and cultivated ground throughout the state.

C. Boscianum, Moquin.* (C. album, L., var. Boscianum, Gray, in *Manual.*) Goosefoot.

Stony Point, lake Madison, Blue Earth county, *Gedge.* South.

C. urbicum, L. *Goosefoot.*

Red river valley at Pembina, *Havard.* Infrequent.

C. urbicum, L., var. *rhombifolium,* Moquin. *Goosefoot.*

Stillwater, *Miss Field.* Infrequent.

C. hybridum, L. *Maple-leaved Goosefoot.*

Frequent, often common, throughout the state.

C. Botrys, L. *Jerusalem Oak. Feather Geranium.*

Northeastward, *Clark;* Minneapolis, *Herrick;* Stillwater (plentiful), *Miss Butler, Miss Field.* Infrequent.

[*C. ambrosioides,* L., will probably extend to Minnesota.]

C. rubrum, L., var. **humile,** Watson. (Blitum maritimum, Nutt.) Coast Blite.

Lapham. Northwest. [Var. HUMILE, Watson. Smaller, prostrate or ascending: leaves ovate to lanceolate, often hastate, an inch long or less, rarely toothed: flowers in axillary or somewhat spicate clusters. *Watson, Botany of California.*]

C. capitatum, Watson. (Blitum capitatum, L.) Strawberry Blite.

Stillwater, *Miss Field;* Stearns county, *Mrs. Blaisdell;* north of lake Superior, *Agassiz;* Carlton county, and Minnesota Point, lake Superior (juice of the fruit used by the Chippewa Indians for staining), *Roberts.* North.

C. Bonus-Henricus, L. (*Blitum Bonus-Henricus,* Reich.) *Good-King-Henry.*

Lake of the Woods, *Dawson.* Rare.

[Atriplex patula, L., var. hastata, Gray, and var. littoralis, Gray, will probably be found on the shore of lake Superior in Minnesota.]

CORISPERMUM, Ant. Jussieu. BUG-SEED.

C. hyssopifolium, L. Bug-seed.

Minnesota Point (plentiful), also near Minneapolis, *Roberts;* northwest beach of Mille Lacs (abundant), *Upham;* Red river, *Hooker, Watson.* Local.

SALICORNIA, Tourn. GLASSWORT. SAMPHIRE.

S. herbacea, L. Glasswort. Samphire.

In the vicinity of a salt spring on the bank of the Red river near Saint Vincent, *Say, Nuttall.* Rare.

SUÆDA, Forskal. SEA BLITE.

S. depressa, Watson.† Sea Blite.

Lapham. Red river valley near Saint Vincent (common), *Upham;* Pembina, dry plains, *Chickering.* Northwest.

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*CHENOPODIUM BOSCIANUM, Moquin. Erect, slender, 2 feet high, loosely branched, nearly glabrous; leaves thin, oblong to linear-lanceolate, 1 to 2 inches long, acute, attenuate into a long, slender petiole, the lower sinuate-dentate, or often all entire; flowers very small, solitary, or in small clusters upon the slender branchlets; calyx green, not strongly carinate, partly covering the at length naked seed, which is ½ line broad. *Watson's Revision of Chenopodium, Proc. Am. Acad.,* vol. ix.

†SUÆDA DEPRESSA, Watson. Annual: low and mostly decumbent, branching from the base, with usually short ascending leafy branchlets: leaves linear, broadest at

AMARANTACEÆ. AMARANTH FAMILY.

AMARANTUS, Tourn. AMARANTH.

A. retroflexus, L. *Pigweed. Red-root.*

A common weed throughout the state.

A. albus, L. *Tumble-weed.*

Frequent southeastward and in the Red river valley; abundant southwestward, on both the longest cultivated and the newly broken land. (North of lake Superior, *Agassiz;* "sandy shore of the upper Missouri" [probably there indigenous, and perhaps so in western Minnesota], *Geyer.*) The popular name alludes to the behavior of this plant in autumn and winter, as described by *Arthur*: "It grows in a globular form, often three or four feet in diameter. When killed by frost, the branches remain rigid, the plant soon loosens from the soil, and the wind drives it bounding over the fields and prairies, until brought up in some fence corner. When the corner is full, those that follow are enabled to scale the fence. With a change of wind, all the lodged plants are set flying in another direction. This is an effective method of scattering the seeds."—Prairie fires are sometimes carried by these rolling dead weeds across broad fire-breaks of plowed land.

A. blitoides, Watson.* Amaranth.

Mankato (a common weed by roadsides and in waste places), *Leiberg;* Martin county, and in Emmet county, Iowa, (rare), *Cratty.* South. "It grows flat upon the ground like purslane, and has a dark green, glossy leaf, not much larger than that of purslane, but thinner. It is a native of the western plains, but is traveling eastward as a weed. It is abundant in Iowa at Clear Lake and southward." *Arthur.*

ACNIDA, L. WATER-HEMP.

A. tuberculata, Moquin. (Montelia tamariscina, Gray, in part, and its var. concatenata, Gray.) Water-Hemp.

St. Croix river, *Parry;* common on gravelly shores of the Le Sueur and Minnesota rivers in Blue Earth county, *Leiberg;* also common in Martin county, and in Emmet county, Iowa, *Cratty.* "Sometimes erect, and from one to four feet high; sometimes spreading or prostrate." South.

FRŒLICHIA, Mœnch. FRŒLICHIA.

F. Floridana, Moquin. Frœlichia.

Lapham. Minneapolis, *Roberts.* Rare. South.

POLYGONACEÆ. BUCKWHEAT FAMILY.

POLYGONUM, L. KNOTWEED. POLYGONUM.

P. viviparum, L. Alpine Bistort.

Grand Marais, lake Superior, *Roberts.* North.

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base, semiterete, ¼ to 1 inch long, the floral ones oblong- to ovate-lanceolate or ovate, acute, rather crowded: calyx cleft to the middle somewhat unequally, one or more of the acute lobes strongly carinate or crested; seed vertical or horizontal, half a line broad, very lightly reticulated. *Watson, Botany of California.*

*AMARANTUS BLITOIDES, Watson. Prostrate or decumbent, the slender stems becoming a foot or two long, glabrous or nearly so; leaves broadly spatulate to narrowly oblanceolate, attenuate to a slender petiole, an inch long or usually less; flowers in small contracted axillary spikelets; bracts nearly a line broad. *Proc. Amer. Acad.*, vol. xii.

P. orientale, L. *Prince's Feather.*
Lake Pepin, *Miss Manning*. Infrequent.

P. Pennsylvanicum, L. Knotweed. Polygonum.
Frequent, or common, through the south half of the state and in the Red river valley.

P. incarnatum, Ell. Polygonum.
Frequent, or common, through the south half of the state.

P. lapathifolium, Ait., var. **incanum**, Koch. Polygonum.
Minneapolis, *Roberts;* lake Pepin, *Miss Manning*. Rare. North.

P. Persicaria, L. *Lady's Thumb. Heartweed.*
Common throughout the state, excepting near its west side, where this and the two following species seem to be less frequent or rare.

P. Hydropiper, L. Common Smartweed or Water-pepper.
Common, often abundant, with range like the last.

P. acre, HBK. Water Smartweed.
Common, with same range.

P. hydropiperoides, Michx. Mild Water-pepper.
Frequent, or common, southward; also found at the lake of the Woods, *Dawson*, and in the Red river valley, *Scott*.

P. amphibium, L., var. **aquaticum**, Willd. Polygonum.
Frequent, often common, throughout the state.

P. Muhlenbergii, Watson.* (P. amphibium, var. terrestre, in *Manual.*) Polygonum.
Common, or abundant, throughout the state.

P. Hartwrightii, Gray.† Polygonum.
Minneapolis (common), *Arthur;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty*. Probably common, or frequent, throughout Minnesota.

P. Virginianum, L. Polygonum.
Lapham. St. Croix river, *Parry*; Blue Earth county, *Leiberg*. South.

P. articulatum, L. Jointweed.
Sandy barrens, St. Croix river, *Parry;* New Ulm, *Juni;* Minnesota Point, near Duluth (plentiful), *Roberts*. [Upper Missouri river, *Geyer*.]

P. aviculare, L. Knotgrass. Goose-grass. Door-weed.
Common throughout the state.

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*POLYGONUM MUHLENBERGII, Watson. Perennial, in muddy or dry places, often 2 or 3 feet high, scabrous with short appressed or glandular hairs, especially upon the leaves and upper stems; leaves thin, rather broadly lanceolate, long-acuminate, usually rounded or cordate at base, 4 to 7 inches long, on short stout petioles (½ to 1 inch long) from near the base of the naked sheath; flowers and fruit nearly as in P. amphibium, but spikes more elongated (1 to 3 inches long), often in pairs. *Proc. Amer. Acad.*, xiv.

†POLYGONUM HARTWRIGHTII, Gray. Strigose-hirsute or glabrous; stem erect, striate, bearing at the top thickish leaves which are broadly lanceolate, acute or somewhat obtuse; petioles short; sheaths long with a flat foliaceous limb, which is setose-ciliate; peduncle erect, eglandulose, bearing a solitary dense cylindrical spike of rose-colored flowers: stamens 5; style deeply cleft: perigonium eglandulose. *Proc. Amer. Acad.*, viii.

P. erectum, L. (P. aviculare. L., var. erectum, Roth.) Erect Knotgrass.

Also common, or frequent: Winona, Blue Earth, Hennepin and Stearns counties, etc.; Worthington (common). *Foote;* Crookston, Grand Forks, and elsewhere in the Red river valley (common), *Winchell;* Pembina, *Havard*.

P. ramosissimum, Michx. Polygonum.

Brown county, *Juni;* Martin county, and Emmet county, Iowa (common), *Cratty;* common from Jackson county westward and in the Red river valley, *Upham*. South and west.

P. tenue, Michx. Slender Knotgrass.

Lapham. Lake Pepin, *Miss Manning;* rocky hills, Mound, Rock county. *Leiberg;* lake of the Woods, *Dawson*. Rare. South and west.

P. arifolium, L. Halberd-leaved Tear-thumb.

Blue Earth county, *Gedge*. Infrequent.

P. sagittatum, L. Arrow-leaved Tear-thumb.

Common near Stewart river (north shore of lake Superior), and at Minneapolis, *Roberts;* Todd county, etc. (common), *Upham;* Stearns county, *Campbell;* Anoka county, also New Ulm, *Juni*.

P. Convolvulus, L. *Black Bindweed.*

Common, or frequent, throughout the state: troublesome in fields of grain by causing it, when beaten down by wind and rain, to remain so.

P. cilinode, Michx. Polygonum.

Abundant north of lake Superior and in Carlton county, *Juni, Roberts;* upper Mississippi river, *Garrison;* Stearns county, *Mrs. Blaisdell.* North.

P. dumetorum, L., var. **scandens**, Gray. Climbing False Buckwheat.

Common, or frequent, throughout the state.

FAGOPYRUM, Tourn. BUCKWHEAT

F. esculentum, Moench. *Buckwheat.*

Occasionally adventive: Minneapolis, and Dakota, Nicollet and Blue Earth counties,

RUMEX, L. DOCK. SORREL.

R. longifolius, DC. Dock.

Hennepin county, *Herrick.* Infrequent. Northwest.

R. Britannica, L. (R. orbiculatus, Gray.) Great Water-Dock.

North of lake Superior (common near Stewart river), *Roberts;* St. Croix river, *Parry:* Isanti county, *Upham;* Stearns county, *Mrs. Blaisdell;* Anoka county, also New Ulm, *Juni;* White Bear lake, Ramsey county, *Kelley;* lake Pepin, *Miss Manning;* Blue Earth county, *Leiberg*.

R. altissimus, Wood. (R. Britannica, L., in *Manual.*) Pale Dock. Peach-leaved Dock.

Upper Mississippi river, *Garrison;* Minneapolis, *Kassube;* Cannon River Falls, *Blake, Sandberg;* lake Pepin, *Miss Manning*; Winona county, *Holzinger;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty*. South.

R. salicifolius, Weinman. White Dock.

Hennepin county, *Herrick;* Kittson county, *Upham*; Pembina, *Chickering, Havard.* [James river, Dakota, *Geyer.*]

R. verticillatus, L. Swamp Dock.

Upper Mississippi river *Garrison;* Isanti county, etc., *Upham;* West Saint Paul, *Miss Butler;* Blue Earth county, *Leiberg;* New Ulm, *Juni*.

R. crispus, L. *Curled Dock. Yellow Dock.*

Common, or frequent, throughout the state.

[*R. obtusifolius*, L., will doubtless extend to Minnesota.]

R. sanguineus, L. *Bloody-veined Dock.*

Chaska, Carver county, *Juni.* Rare

R. maritimus, L. Golden Dock.

Minneapolis, *Roberts, Upham;* Chaska, Carver county, *Juni;* Blue Earth county, *Leiberg;* Emmet county, Iowa, (rare), *Cratty;* Murray county, and the Red river valley, *Upham;* Pembina, *Havard.* South and west.

R. Acetosella, L. *Field* or *Sheep Sorrel.* "*Horse Sorrel.*"

Common throughout the state; plentiful all along the north shore of lake Superior, *Roberts, Juni.*

THYMELEACEÆ. MEZEREUM FAMILY.

DIRCA, L. LEATHERWOOD. MOOSE-WOOD.

D. palustris, L. Leatherwood. Moose-wood.

Common northeastward, extending thus west to the lake of the Woods, *Richardson,* White Earth reservation, *Garrison,* and Detroit, *H. B. Ayres,* and south to the Kettle river, *Shumard,* southeastern Pine county, *Upham,* and St. Croix Falls, *Miss Field;* frequent, but local, farther south, as near Minneapolis, *Simmons,* Saint Paul, *Miss Cathcart,* Hastings, *Mrs. Ray,* Faribault, *Miss Beane,* Blue Earth county (common), *Leiberg,* New Ulm, *Juni,* and near the Great spring, Beaver creek, Caledonia, Houston county, *Winchell.*

ELÆAGNACEÆ. OLEASTER FAMILY.

SHEPHERDIA, Nutt. SHEPHERDIA.

S. Canadensis, Nutt. Canadian Shepherdia.

From lake Winnipeg to lake Superior, *Say, Schweinitz;* north shore of lake Superior, *Juni;* Minneapolis (rare), *Miss Butler.* North.

S. argentea, Nutt. Buffalo-Berry.

Rainy lake, *Say, Schweinitz;* upper Minnesota river, *Geyer;* near Walhalla, in northeastern Dakota, *Scott.* Northwest.

ELÆAGNUS, L. OLEASTER.

E. argentea, Pursh.* Silver-Berry.

Common from Ada northward in the Red river valley (forming patches ten to twenty rods long on the prairie, growing only about two feet high, fruiting plentifully; but in thickets becoming five to eight feet high), and local in section 5, Eldorado, Stevens county, *Upham.* Northwest.

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*ELÆAGNUS, L. Flowers perfect. Calyx-tube including the free ovary, the limb cylindric-campanulate or tubular below, parted above into 4 valvate deciduous lobes, colored within. Disk glandulose. Stamens 4, adnate to the calyx and alternate with its lobes, the free portion of the filaments very short; anthers oblong. Style simple, straight; stigma 1-sided. Fruit drupe-like, covered with the thickened dry or fleshy closed calyx-tube; the stone oblong, 8-striate.—Trees or shrubs, with alternate entire petioled leaves and axillary pedicelled flowers.

E. ARGENTEA, Pursh. A stoloniferous unarmed shrub, 6 to 12 feet high, the younger branches covered with ferruginous scales; leaves 1½ to 4 inches long and ¾ to 2½ inches

SANTALACEÆ. SANDALWOOD FAMILY.

COMANDRA, Nutt. BASTARD TOAD-FLAX.

C. pallida, A. DC.* Bastard Toad-flax.

Red river valley, *Scott*, determined by *Mr. Sereno Watson*. West.

C. umbellata, Nutt. Bastard Toad-flax.

Common throughout the state.

C. livida, Richardson. Bastard Toad-flax.

North shore of lake Superior, *Juni;* Stearns county, *Mrs. Blaisdell.* [Isle Royale (common), *Whitney*.] North.

SAURURACEÆ. LIZARD'S-TAIL FAMILY.

SAURURUS, L. LIZARD'S-TAIL.

S. cernuus, L. Lizard's-tail.

Upper Mississippi river, *Houghton*. Infrequent.

CERATOPHYLLACEÆ. HORNWORT FAMILY.

CERATOPHYLLUM, L. HORNWORT.

C. demersum, L. Hornwort.

White Bear lake, Ramsey county, *Kelley;* lake Calhoun, Minneapolis, *Upham;* small lakes at the Pipestone quarry (var. commune, Gray, with fruit about 3 lines long, tipped with the stout straight style also about 3 lines long, and with a similar short spine, 2 lines long, at the base on each side), *Mrs Bennett*. Probably common throughout the state.

CALLITRICHACEÆ. WATER-STARWORT FAMILY.

CALLITRICHE, L. WATER-STARWORT.

C. verna, L. Water-Starwort.

Throughout the state. North of lake Superior (common), *Roberts;* Pembina, *Havard;* Cottonwood county, *Upham.*

[C. autumnalis, L., probably occurs also in northern Minnesota.]

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wide, broadly or narrowly elliptic, rather acute at each end, or lanceolate and undulate, silvery-scurfy and more or less ferruginous; flowers numerous, deflexed, silvery without, pale yellow within, fragrant, 3 to 5 lines long, the tube broadly oval, the limb funnelform ; fruit [silvery in color, like the foliage] globose-ovoid, dry and mealy, edible, 4 or 5 lines in length. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

*COMANDRA PALLIDA, A. DC. Stems several from a branched woody caudex, herbaceous, striate, erect, 6 to 10 inches high, branching above ; leaves alternate, bluish, somewhat punctate on the margins, the lower elliptic oblong, mucronate-acute, 8 to 12 lines long and 2 to 3 lines wide, the uppermost usually linear-lanceolate, 5 to 10 lines long and about 1 line wide, sometimes so continued down the stem (forming var. angustifolia) ; cymes terminal, few-flowered ; bracts linear-lanceolate, 2 lines long ; flowers perfect ; calyx-lobes erect-spreading ; fruit 3 lines in diameter, with subfleshy epicarp.—Flowers precisely as in C. umbellata ; distinguished especially by its narrowed upper leaves and much larger fruit. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

PODOSTEMACEÆ. RIVER-WEED FAMILY.

PODOSTEMON, Michx. RIVER-WEED.

P. ceratophyllus, Michx. River-weed.
Lake Pepin, *Miss Manning*. Rare.

EUPHORBIACEÆ. SPURGE FAMILY.

EUPHORBIA, L. SPURGE.

E. polygonifolia, L. Shore Spurge.
Lapham. Shore of lake Superior; lake Pepin, *Miss Manning*.

E. Geyeri, Engelm. Geyer's Spurge.
Lapham, T. J. Hale. Common at Minneapolis, *Upham, Simmons.*

E. serpyllifolia, Pers. Thyme-leaved Spurge.
Minneapolis, *Herrick;* Blue Earth county, *Leiberg;* Martin county, *Gedge;* New Ulm, *Juni;* Murray county, *Upham;* Stearns county, *Mrs. Blaisdell;* Pembina, *Havard.*

E. glyptosperma, Engelm. Spurge.
Minneapolis, *Herrick;* Saint Cloud, *Campbell;* Red river valley, *Scott.*

E. maculata, L. Spotted Spurge.
Common through the south half of the state and perhaps northward.

E. humistrata, Engelm. Spurge.
Minneapolis, *Roberts;* Winona county, *Holzinger;* Martin county, *Gedge.* South.

E. hypericifolia, L Spurge.
Waste, dry places. St. Croix river, *Parry;* Minneapolis, *Roberts;* lake Pepin, *Miss Manning;* Winona county, *Holzinger;* Blue Earth county, *Leiberg.* South.

E. marginata, Pursh. White-margined Spurge. "Mountain Snow."
Frequent, often common, southwestward; extending northeast to Redwood Falls (found to be poisonous to the touch, even in mounting dried specimens), *Miss Butler;* in Lyon county becoming a common weed in cultivated fields, *Upham.*

E. corollata, L. Flowering Spurge.
Frequent, often common, through the south half of the state.

E. heterophylla, L. Spurge.
Spirit lake, Minnesota river, etc., *Geyer;* Blue Earth county, *Leiberg, Gedge;* Minneapolis, *Twining, A. W. Jones;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning.* South.

E. dictyosperma, Fischer & Meyer. Spurge.
Rock county, *Leiberg.* Southwest.

E. Cyparissias, L.* *Garden Spurge.*
Adventive: Mankato, *Leiberg;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning.*

[E. commutata, Engelm., should be looked for in this state.]

ACALYPHA, L. THREE-SEEDED MERCURY.

A. Virginica, L. Three-seeded Mercury.
Minneapolis, *Roberts;* Blue Earth county, *Leiberg;* lake Pepin, *Miss Manning.*

EMPETRACEÆ. CROWBERRY FAMILY.

EMPETRUM, Tourn. CROWBERRY.

E. nigrum, L. Black Crowberry.

North shore of lake Superior, *Macoun*; doubtless in northern Minnesota.

URTICACEÆ. NETTLE FAMILY.

ULMUS, L. ELM.

U. fulva, Michx. Slippery or Red Elm.

Frequent, often common, throughout the state, excepting far northward. Well known for its mucilaginous, medicinal inner bark; the reddish wood, used for ox-yokes, posts, etc., is strong, light and durable.

U. Americana, L. White Elm. Amercian Elm. Water Elm.

Common throughout the state; but not found close to the shore of lake Superior. Wood tough, often used for axe-helves, whip-stocks, etc.; our most desirable tree for transplanting for ornament and shade. This and basswood are the most abundant trees in the Big Woods.

U. racemosa, Thomas. Corky White Elm. Rock Elm.

Frequent, often common, eastward; extending west to Blue Earth county, *Leiberg*, Nicollet county, *Aiton*, New Ulm (common), *Juni*, and the upper Mississippi river, *Garrison*. Wood drier than the last and more valuable; much used by wheelwrights.

CELTIS, Tourn. NETTLE-TREE. HACKBERRY.

C. occidentalis, L. Sugarberry. Hackberry.

Frequent through the south half of the state; rare and local northward, as at the east side of Mille Lacs and at lake Alexander, *Upham*; near lake Lida, Otter Tail county, *Frazee*; on the Red river in Clay county; at Red Lake Falls; on the upper Mississippi; and on the Big Fork of Rainy Lake river, in T. 149, R. 26, *Hinchellwood*. [Also at Eagle lake, north of Rainy lake, *Bell*, *Macoun*; and in northeastern Dakota, *Scott*.]

MORUS, Tourn. MULBERRY.

M. rubra, L. Red Mulberry.

Big Woods, *Winchell*; Houston county, *J. S. Harris*. [West to Dakota, *Sargent*, and eastern Nebraska, *Aughey*.] Infrequent. South.

URTICA, Tourn. NETTLE.

U. gracilis, Ait. Tall Wild Nettle.

Common throughout the state.

U. dioica, L. *Great Stinging Nettle*.

Upper Mississippi river, *Garrison*; lake Pepin, *Miss Manning*. Rare.

LAPORTEA, Gaud. WOOD-NETTLE.

L. Canadensis, Gaud. Wood-Nettle.

Common through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river and Roseau river. "It is of this plant the Indians usually make their fishing lines, the rotted remains of the previous year's growth furnishing an abundant supply." *Parry*.

PILEA, Lindl. Richweed. Clearweed.

P. pumila, Gray. Richweed. Clearweed.

St. Croix river, *Parry;* Minneapolis, *Simmons;* lake Minnetonka (common), *Roberts;* Blue Earth county, *Leiberg*; Fergus Falls, *Leonard.* South.

BŒHMERIA, Jacq. False Nettle.

B. cylindrica, Willd. False Nettle.

Lapham. Fergus Falls, *Leonard.* Infrequent.

PARIETARIA, Tourn. Pellitory.

P. Pennsylvanica, Muhl. Pellitory.

Minneapolis (presenting, besides the type, a larger and much branched form), *Herrick, Simmons;* Blue Earth county, *Leiberg;* and northwest to the upper Missouri and Saskatchewan rivers. Infrequent. South and west.

CANNABIS, Tourn. Hemp.

C. sativa, L. *Hemp.*

A common or frequent weed.

HUMULUS, L. Hop.

H. Lupulus, L. Common Hop.

Common, especially northward; "native on all the tributaries of the upper Mississippi," *Parry.*

PLATANACEÆ. Plane-tree Family.

PLATANUS, Tourn. Plane-tree. Buttonwood.

P. occidentalis, L. American Plane-tree. Buttonwood. Sycamore.

Lapham. Southeast, rare. The northwest limit of this species scarcely enters Minnesota.

JUGLANDACEÆ. Walnut Family.

JUGLANS, L. Walnut.

J. cinerea, L. Butternut. Oil-nut. White Walnut.

Common southward, but absent far southwest; extending north to the Snake river in Pine and Kanabec counties, *Norwood, Upham,* and on the Mississippi river to the north line of Aitkin county, *Garrison.* Wood valuable for cabinet work and in house-building for inside finishing

J. nigra, L. Black Walnut.

Frequent in the south part of the state; extending north to Nininger, Dakota county, southern Scott and Carver counties, and to Walnut Grove in the south edge of Redwood county. Because of the great value of its lumber, nearly all the black walnut of large size in this state has been cut; but much of young growth remains.

CARYA, Nutt. Hickory.

C. alba, Nutt. Shell-bark or Shag-bark Hickory. "Walnut."

Common, or frequent, in Houston county; extending north into Winona county at least to Winona and Stockton, and west (rare) into Fillmore, Mower and Freeborn counties, to Moscow, *Winchell;* near Weaver and Kellogg, Wabasha county, and near Chatfield, on the south line of Olmsted county, *W. D. Hurlbut.* Southeast. "Timber very valuable, used wherever great durability, strength and elasticity are required."

C. porcina, Nutt. Pig-nut or Broom Hickory.

Lapham. Southeastward, extending north to Snake river, *Clark;* near lake Pepin on the Wisconsin side, *Mrs. Ray.*

C. amara, Nutt. Bitter-nut or Swamp Hickory.

Common, or frequent, southward; extending through the Big Woods, and north to Mille Lacs, and sparingly to the upper Mississippi river, and to Whiteface river, tributary to the St. Louis river. This species furnishes nearly all the hoop-poles for flour-barrels cut in the southern and central portions of the state.

CUPULIFERÆ. OAK FAMILY.

QUERCUS, L. OAK.

Q. alba, L White-Oak.

Frequent, or common, in the southeast and central parts of the state; extending north to Fond du Lac, *Clark,* Savannah river, and Squagemaw lake, *Winchell,* and to Pokegema falls, Pemidji lake (plentiful in many places on the upper Mississippi river), and the White Earth reservation, *Garrison.* "Strong, durable, and beautiful timber."

Q. stellata, Wang. (Q. obtusiloba, Michx.) Post-Oak. Rough or Box White-Oak.

Upper Mississippi river, *Houghton.* Infrequent.

Q. macrocarpa, Michx. Bur-Oak. Over-cup or Mossy-cup White-Oak.

Common, or abundant, throughout the state, excepting far northeastward. Its northeastern limit north of lake Superior, according to *Bell,* is near the international boundary; but he states that it attains a good size on the Rainy river and thence westward. ("In going west, this species is first met with at the east end of Eagle lake" [north of Rainy lake], *Macoun.*) Timber valuable, similar to that of white oak.

Q. bicolor, Willd. Swamp White-Oak.

Frequent in Benton, Mille Lacs and Morrison counties, and thence north to lake Winnibigoshish and the White Earth reservation, *Garrison.*

Q. Muhlenbergii, Engelm. (Q. Prinus, L., var. acuminata, Michx.) Yellow Chestnut-Oak.

Lapham. Southeast.

Q. tinctoria, Bartram. (Q. coccinea, Wang., var. tinctoria, Gray.) Black Oak. Quercitron or Yellow-barked Oak.

Common, or abundant, southward; extending north to Pine county, *Upham,* and to Pokegama falls and the White Earth reservation, *Garrison;* the most abundant species of oak in the southeast part of the state. This species and the bur oak vary from 20 to 50 or 60 feet in hight, according to their situation and soil; besides which, each occurs frequently dwarfed, growing as scrubby brush from 3 to 10 feet high.

Q. coccinea, Wang. Scarlet Oak.

Upper Mississippi river, *Garrison;* "in Minnesota (*Engelmann*)," *Sargent.*

Q. coccinea, Wang., var. **ambigua,** Gray. Gray Oak.

Prairie river, attaining a hight of 50 feet and diameter of 10 inches, *Clark;* White Earth reservation, *Garrison.* North.

Q. rubra, L. Red Oak.

Occasional southward, and north to the upper Mississippi river, *Geyer*, *Garrison;* continuing on the north side of lake Superior to the Kaministiquia river, *Bell*, *Macoun*.

In autumn the leaves of the black and red oaks change to red and crimson colors; while the foliage of the white and bur oaks changes only to dull green, gray and brown. At the same time the leaves of the sumachs and red maple become red or scarlet; of the sugar maple, yellow; and of bass, box-elder, ash trees, elms, poplars, and cottonwood, various shades of brown and yellow.

Q. palustris, Du Roi. Swamp Spanish Oak. Pin Oak.

Lapham. Upper Mississippi river, *Garrison*.

[*Sargent* and *Bell* have mentioned Minnesota as a western limit of the American beech (Fagus ferruginea, Ait.), but it probably does not extend into this state.]

CORYLUS, Tourn. HAZEL-NUT. FILBERT.

C. Americana, Walt. Common Wild Hazel-nut.

Common, in many districts abundant, throughout the state.

C. rostrata, Ait. Beaked Hazel-nut.

Common northward; extending south to Benton county and Spruce Hill, Douglas county, *Upham;* rare and local farther south, as on rocky bluffs in southeastern Winona county, *Winchell*. *Juni* says of this species north of lake Superior: "In some places the bushes reach a hight of fifteen feet, with stems from one to one and a half inches in diameter. The tops bend over from the weight of the fruit."

OSTRYA, Micheli. HOP-HORNBEAM. IRON-WOOD.

O. Virginica, Willd. American Hop-Hornbeam. Iron-wood. Lever-wood.

Common, often abundant, throughout the state; but not close to the shore of lake Superior.

CARPINUS, L. HORNBEAM. IRONWOOD.

C. Caroliniana, Walt. (C. Americana, Michx.) American Hornbeam. Blue or Water Beech.

Common through the south half of the state; extending north to Pine county and Sandy lake, *Clark*, the Savannah portage, *Winchell*, and White Earth reservation, *Garrison*. "Wood of this and the preceding tough and durable; used for wedges, levers, &c."

MYRICACEÆ. SWEET-GALE FAMILY.

MYRICA, L. BAYBERRY. WAX-MYRTLE.

M. Gale, L. Sweet Gale.

Common on lake-shores, along the international boundary, between lake Superior and Rainy lake, *Winchell*. North.

COMPTONIA, Solander. SWEET-FERN.

C. asplenifolia, Ait. Sweet-Fern.

Frequent northeastward; extending south to Snake river in southeastern Pine county, *Upham*, and southwest to Cass lake, *Schoolcraft;* it also occurs at Jacob Streitz's quarry in section 28, Saint Cloud, *Upham*, and near Excelsior, Hennepin county, *Mrs. Terry*.

BETULACEÆ. Birch Family.

BETULA, Tourn. Birch.

[B. lenta, L. (cherry birch, sweet or black birch) possibly extends west to northern Minnesota. *Dr. Bell* mentions this state as its northwestern limit. Some of the more northern references under B. nigra may belong instead to this species.]

B. lutea, Michx. f. Yellow or Gray Birch.

Common through the north half of the state and south to Sherburne county, reaching a hight of 75 feet and diameter of 3 or 4 feet; rare in the Big Woods, and southeast to Houston county, *Winchell.* "The 49th parallel forms the average northern limit of this species from Newfoundland to the Red river valley, in which it curves round and runs southward." *Bell.*

B. papyracea, Ait. Paper or Canoe Birch. Silver Birch.

Common, often abundant, through the north half of the state, attaining an equal size with the preceding; also common, but much smaller, southeastward near the Mississippi river; thence extending west, less frequent, to the Big Woods, and to Birch Cooley (plentiful), Renville county; absent southwestward; "found along the Assiniboine valley as far west as the Qu'Appelle lakes," *Bell.* "The bark of this tree, together with that of the Arbor-vitæ, is made use of in innumerable ways by the Indians." *Roberts.*

B. nigra, L. River or Red Birch.

Savannah portage, *Douglass;* White Earth reservation, *Garrison;* Kettle river, *Shumard;* Blue Earth county, *Nicollet;* Winona county, *Holzinger;* abundant along the Mississippi bottoms at least as far north as Minneiska, Wabasha county, *Winchell.* Southeast.

B. pumila, L. Low Birch. "Tag Alder."

Common through the north half of the state, and south to Minneapolis and Saint Paul; less frequent or rare farther south, to lake Pepin, *Miss Manning,* and Olmsted county, *Barrington.*

B. glandulosa, Michx. Dwarf Birch.

Savannah river, *Houghton;* north shore of lake Superior, *Juni, Winchell;* ridge east of the Red river, *Scott.* North.

ALNUS, Tourn. Alder.

A. viridis, DC. Green or Mountain Alder.

North of lake Superior (common), *Juni, Roberts.* North.

A. incana, Willd., var. **glauca,** Regel. Speckled or Hoary Alder. Black Alder.

Common, or frequent, through the north half of the state, and southeastward to Minneapolis; less frequent thence southeast; rare southwestward.

A. serrulata, Ait. Smooth Alder.

Lapham, Winchell. Rare. Southeast.

SALICACEÆ. Willow Family.

SALIX, Tourn. Willow. Osier.

S. candida, Willd. Hoary Willow.

Throughout the state, excepting far southward. Bogs, St. Croix river, *Parry;* Minneapolis, *Kassube;* Blue Earth county, *Leiberg;* New Ulm, *Juni;* north of lake Superior, *Agassiz;* upper Mississippi river, *Garrison;* Red river valley, *Macoun.*

S. tristis, Ait. Dwarf Gray Willow.

Lapham. Minneapolis, *Winchell;* Blue Earth county, *Leiberg;* Lake City, *Mrs. Ray.*

S. humilis, Marshall. Prairie Willow.

Blue Earth county, *Leiberg, Upham;* frequent in Emmet county, Iowa, *Cratty;* abundant near the Mississippi river, on dry, sandy land, especially in openings of woods, from lake Pepin, *Miss Manning, Mrs. Ray,* and Ramsey county, north at least to Brainerd (usually only about one foot high, agreeing best, excepting in habitat, with Gray's description of S. tristis), *Upham;* north of lake Superior, *Agassiz.* Probably throughout the state.

S. discolor, Muhl. Glaucous Willow. Pussy Willow.

Common, or frequent, throughout the state.

[S. sericea, Marshall, probably occurs, but infrequently, in Minnesota.]

S. petiolaris, Smith.[*] Petioled Willow.

Freeborn county (frequent), *Upham.* Probably our prevailing form of this species is var. GRACILIS, Anders. (*M. S. Bebb.*)

S. purpurea, L. *Purple Willow.*

Minneapolis, *Simmons.* Infrequent.

S. cordata, Muhl. Heart-leaved Willow.

Common, or frequent, throughout the state.

S. cordata, Muhl., var. **angustata,** Gray.

Stearns county, *Garrison.* [North of lake Superior, *Agassiz;* Nebraska (common), *Aughey.*]

S. balsamifera, Barratt.[†] (S. pyrifolia, Anders.; see notes by *M. S. Bebb* in *Botanical Gazette,* vol. iv, p. 190.) Balsam-bearing Willow.

Red river valley near Saint Vincent, *Burgess, Macoun.* North.

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[*] SALIX PETIOLARIS, Smith, var. GRACILIS, Anders. Female aments gracefully subpendulous, at length somewhat leafy-peduncled, very loosely flowered; scales lingulate, apex brownish; capsules long acute-rostrate from an ovate base, thinly silky, or somewhat glabrous, very long-pediceled; pedicel nearly eight times the length of the nectary; style very short; stigmas 2-parted, fuscous, spreading; leaves narrowly lanceolate-linear, serrulate, about 2 inches long and 2 to 4 lines wide, pale and subglaucous beneath, both sides at length glabrous. Varies: 1st, sericocarpa; capsules narrowly conical, 2½ lines long, thinly silky. 2d, leiocarpa; capsules thick at base, greenish red. *Andersson* in *DC. Prod.,* 16, 2, 235; translated by *M. S. Bebb.*

[†] SALIX BALSAMIFERA, Barratt. A glabrous, much branched shrub, 4 to 8 feet high; twigs crimson where exposed to the sun; leaves ovate, abruptly pointed, 1 inch wide by 1½ inches long, on sterile shoots oblong-lanceolate, 1½ inches wide by 3 to 4 inches long, all rounded or subcordate at base, very thin and slightly hairy beneath when young, rigid, glabrous, and prominently reticulate-veined when mature, bright green above, paler or glaucous beneath, margin finely glandular-serrate; petioles slender, ½ inch long; stipules minute, caducous: aments with a few leaf-like bracts at base, the male densely flowered, very silky, female less so and becoming very lax in fruit, bracts often more leafy; scales pale or rosy; capsules elongate-conical or rostrate from a thick base, 2 or 3 lines long, glabrous, the long pedicels six to eight times the length of the nectary; style rather short, bifid; lobes of the stigma thick, spreading, emarginate. "No. 53, Herb. H., B. and T." (v. s. in h. Torr.) S. cordata, Muhl., var. balsamifera, Hook., *Fl. Bor.-Am.,* 2, 149. S. pyrifolia, Anders., *DC. Prod.,* 16, 2, 264.—White mountains of N. H., *Pringle;* New Brunswick, *Fowler;* and Labrador, *Allen;* westward to the Saskatchewan. Readily distinguished from S. cordata by the very loosely flowered fertile aments, often two inches or more long in fruit, thicker and more yellowish staminate aments, and the proportionately broader and shorter Amelanchier-like leaves. *M. S. Bebb, MSS.*

S. rostrata, Richardson. (S. livida, Wahl., var. occidentalis, Gray.) Beaked Willow. Livid Willow.

Common throughout the state.

S. lucida, Muhl. Shining Willow.

Common, or frequent, throughout the state.

S. nigra, Marshall. Black Willow

Throughout the state; frequent northward, common southward. This and the next are our only native species of willow that become trees, the others being shrubs.

S. amygdaloides, Anders.* Almond-leaved Willow.

Red river and eastward, *Bebb;* probably frequent throughout the state.

S. fragilis, L. X *alba,* L. *White Willow.*

Occasionally spontaneous; much cultivated, especially on the prairies, for shade and protection from the wind. Timber culture, of this tree, red and sugar maple, box-elder, cottonwood, Lombardy poplar, and other species, is being begun extensively in the prairie region, chiefly for the rewards provided by laws of the state and United States governments. The white willow is well adapted to yield fuel, as it grows rapidly, and, when cut down, shoots up vigorously anew from the stump. In good soil, with good care, probably ten acres of this willow would supply an average household with fire-wood continually.

M. S. Bebb regards this "white willow," commonly planted (by cuttings) for screens, as a hybrid of *S. fragilis* and *S. alba,* being apparently the form named *S. fragilis,* L., var. *Russelliana,* Carey, in Gray's *Manual.* Mr. Bebb writes: "Among the varieties cultivated throughout the Northwest, I have seen no genuine *S. alba.* In one form, *S. fragilis* X *alba,* var. (c.) *vestita,* Wimmer (*S. palustris,* Host.), the leaves approach very near to *S. alba,* var. *cærulea,* but the flowers are different. Much the more commonly planted form is *S. fragilis* X *alba,* var. (b.) *glabra,* Wimmer (exactly *S. excelsior,* Host.; *S. viridis,* Fries, when the under surface of the leaf is pale green)."

S. longifolia, Muhl. Long-leaved Willow. Sand-bar Willow.

Common throughout the state.

S. myrtilloides, L. Myrtle Willow.

Frequent northward, rare southward. Swamps, St. Croix river, *Parry;* north of lake Superior, *Agassiz;* Kanabec and Benton counties, *Upham;* Dellwood, White Bear lake, Ramsey county, *Kelley;* Minneapolis, *Kassube;* near Eagle lake, Blue Earth county, *Leiberg;* Emmet county, Iowa (rare), *Cratty.*

POPULUS, Tourn. POPLAR. ASPEN.

P. tremuloides, Michx. American Poplar or Aspen.

Common, or abundant, throughout the state, especially northward. Wood of this and the next is valuable for paper-making.

P. grandidentata, Michx. Large-toothed Poplar or Aspen.

Common, or frequent, throughout most of the state; excepting the southeastern

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*SALIX AMYGDALOIDES, Anders. Leaves broadly lanceolate, 3 to 6 inches long, ½ to 1½ inches wide, with a long tapering point, glaucous beneath, closely serrate, petioles long and slender, stipules minute and very early deciduous: aments leafy-peduncled, elongated-cylindrical, pendulous; the fertile when in fruit lax, 3 to 4 inches long, ½ inch thick: scales in the male ament ovate, villous with crisp hairs, in the female narrower, somewhat smooth, fugacious: capsules globose-conical, glabrous, long-pedicelled; style very short or obsolete, stigmas notched. . . . In aspect very unlike S. nigra [like which, this species attains a tree-like size], and in fact more frequently mistaken for S. lucida. The broad leaves, being supported by long and slender petioles, are moved by the slightest breeze, displaying in rapid, fluttering succession their conspicuous white under surfaces, thus producing an effect in striking contrast with the changeless, soft light reflected from masses of the foliage of S. nigra when swayed gently by the wind. *Bebb* in *Wheeler's Report of Surveys west of the One Hundredth Meridian.*

counties and far northward, where it occurs sparingly, and southwestward, where it is absent.

P. monilifera, Ait. (Including P. angulata, Ait.) Cottonwood. Necklace Poplar.

Common, or frequent, through the south half of the state; rare farther north; reaching its northern limit in southeastern Pine county, the region of the upper Mississippi, *Houghton*, White Earth reservation, *Garrison*, and Red Lake Falls and the Red river valley, *Upham*. "Large trees occur along the Assiniboine river," *Bell.* "Extensively planted for shelter and fuel. The cotton from the seeds proves a source of much annoyance to the tidy housewife. If only male trees, those with reddish tassels, were planted, no cotton would be produced. Both kinds of tassels, the green and the red, appear in spring before the leaves come out." *Arthur.*

P. balsamifera, L. Balsam Poplar. Tacamahac.

Common, or frequent, through the north half of the state; extending southwest to Cannon river (rare), *Sandberg*, Osakis lake, *Upham*, and Fergus Falls, *Leonard.*

P. balsamifera, L., var. **candicans,** Gray. Balm of Gilead.

Frequent northeastward; extending southwest to southeastern Pine county, Little Falls, and White Earth reservation.

P. dilatata, Ait. *Lombardy Poplar.*

Spontaneous, Mankato, *Leiberg.* [Stiff spiry tree, with closely appressed branches, and small broadly triangular pointed leaves; formerly much planted. *Gray's Field, Forest, and Garden Botany.*]

P. alba, L. *White Poplar. Silver-leaf Poplar. Abele. Abel-tree.*

Cultivated, and thence sometimes spreading spontaneously, in Martin county, *Cratty.* [Tree planted from Europe, with spreading branches, roundish, slightly heart-shaped wavy-toothed or lobed leaves soon green above, very white cottony beneath; buds not glutinous: spreads inveterately by the root. *Gray's Field, Forest, and Garden Botany.*]

CONIFERÆ. PINE FAMILY.

PINUS, Tourn., Link. PINE.

P. Banksiana, Lambert. "Jack Pine." Gray or Northern Scrub Pine. Banks' or Banksian Pine. Black Pine.

Common northeastward; abundant on sandy land in the region of the upper Mississippi and Crow Wing rivers, from Brainerd and Wadena northward; having its southwest limit at the St. Croix and Snake rivers, Princeton, Brockway (Stearns county), Stowe and Oak Valley (ten miles south of Wadena), in the White Earth reservation, and at the lake of the Woods and on Roseau river. This species, almost alone, but with red pines here and there sparingly intermixed, forms thick woods at many places in Cass, Wadena and Crow Wing counties, as, for example, at Brainerd, growing very straight and slender, 40 to 60 feet in hight, but seldom exceeding a foot in diameter. Its coarse, resinous wood is excellent fuel, but it is not adapted to building purposes. Many railroad ties are made from this and the next species of pine, but are inferior in value and durability to those of bur oak, which are more used in this way. Often five ties, each eight feet long, are obtained from a single Jack pine. Rarely this tree attains a hight of eighty feet, one of this size being found by *Professor Winchell* on Brule mountain, north of lake Superior. [This tree grows sixty to seventy feet high in northern Michigan (*Wheeler and Smith's Catalogue*, and *Bulletin of the Torrey Botanical Club*, x, 82); and *Dr. Bell* records it as about seventy feet in hight and two feet in diameter, in large groves, on the southern branches of the Albany river.]

P. resinosa, Ait. "Norway Pine." Red Pine.

Common or frequent northward, growing in groves, or scattered, on somewhat sandy land; not extending, in general, quite so far southwest as the preceding. Usually called "Norway pine"; but wrongly, for this species is not found in Norway, nor in Europe. It is mostly from 50 to 75 feet high, but seldom more than about a foot in diameter. *Clark* reports that it attains a hight of 90 feet and diameter of 20 inches, north of lake Superior. It is considerably sawn for lumber, and is also much used for piles, as for wharves and foundations of bridge piers. In the region of the upper Mississippi this species is reported by *Garrison* as occurring in two varieties, which are distinguished by lumbermen under the names Hard Norway pine and Red-barked Norway pine.

P. Strobus, L. White Pine.

Common through the north half of the state, excepting west of Red lake and the lake of the Woods; preferring somewhat clayey land, occasionally making a majestic forest without intermixture of other large trees, but oftener associated with maple, elm, bass, oak, ash, and other deciduous species; frequent along the north side of lake Superior, but forming no extensive pine forest on the immediate shore. This is the largest, as well as the most useful, of our trees, growing from 80 to 125, rarely 150, feet in hight, and from three to six feet in diameter.

The southwestern limit of the pineries extends from the north edge of Chisago county westerly through Kanabec and Mille Lacs counties, the northeast corner of Benton county, Morrison county, and northeastern Todd county, to Pine lakes, Frazee City, and the White Earth reservation; but only a comparatively small part of the region northeast of this line is covered with pine woods. Southeastward, beyond this limit, white pine occurs rarely and locally in the vicinity of the Mississippi, St. Croix, Cannon, Zumbro and Root rivers, in most instances on bluffs of these or their tributary streams; as at Saint Cloud, Dayton, Minnehaha falls, Pine Bend, Taylor's Falls, Franconia (where it was first cut in Minnesota, to any considerable extent, for lumber), near Cannon River Falls, near Mantorville, near Rochester, in section 29, Saint Charles, Winona county, and at various points in Fillmore and Houston counties.

Mr. Platt B. Walker, of Minneapolis, editor of the *Lumberman and Manufacturer*, states that approximately 400,000,000 feet (board-measure) of pine are annually cut in the north central part of this state, on the Mississippi river and its tributaries, about three-quarters of which are sawed at Minneapolis; and that some 200,000,000 feet are annually cut on the St. Croix river and its branches, about half of which is cut in Minnesota, chiefly on the Snake river, the amount sawed at Stillwater being some 100,000,000 feet yearly. Throughout these districts about three-quarters of the timber cut are white pine, and the remainder red or Norway pine. Much white pine is also cut on the St. Louis river, the Otter Tail river, Clearwater river (a tributary of Red Lake river), and recently on the Rainy Lake river; and red pine is cut on Pine creek, tributary to Roseau lake and river, west of the lake of the Woods.

The amount of merchantable pine standing in Minnesota in 1880 was estimated by *C. S. Sargent*, special agent of the United States census, at 6,100,000,000 feet; and the amount cut in the state during the preceding year is reported to be 540,997,000 feet.

PICEA, Link. SPRUCE.

P. nigra, Link. (Abies nigra, Poir.) Black Spruce. Double Spruce.

Common northeastward; extending south to Chisago and Isanti counties, and west to Spruce Hill, Douglas county, the White Earth reservation, Red lake, and the lake of the Woods and Roseau river. It attains, in favorable situations, a hight of 70 feet and diameter of 18 inches, *Clark;* but usually it is small, and none of it is cut for lumber in this state.

P. alba, Link. (A. alba, Michx.) White Spruce. Single Spruce.

Common far northward; extending south to Moose Lake, Carlton county, *Upham*, and to the upper Mississippi river and White Earth reservation, *Garrison*, and west to the lake of the Woods and Roseau river; 20 feet high, 8 inches in diameter, *Clark*.

TSUGA, Carrière. HEMLOCK-SPRUCE.

T. Canadensis, Carrière. (Abies Canadensis, Michx.) Hemlock-Spruce. Hemlock.

Mentioned by *Nicollet* as observed in the region of the upper Mississippi, and by

Norwood in the valley of the St. Louis river; included in *Dr. Lapham's* catalogue; also reported as occurring, locally, near Pokegama lake, Cass county, and at the north side of Sand lake, in the southwest part of T. 46, R. 19, Carlton county, and in other parts of this county, as on Black Hoof creek; all of which need verification. Though plentiful not far eastward in Wisconsin, it extends very scantily, if at all, into Minnesota. ["On the south shore of lake Superior it does not reach the western extremity, turning southward in the neighborhood of Ashland. I am informed, however, that there is an outlying grove of hemlock at Thomson, about twenty-five miles west of Duluth. This tree maintains a good size to the verge of its range, and always appears to terminate abruptly." *Bell.*]

ABIES, Link. FIR.

A. balsamea, Marshall. Balsam Fir.

Common northeastward, attaining a hight of 50 feet, *Clark;* extending south and west to nearly the same limits as the black spruce; also farther south, rare and local, as near Mantorville, Dodge county, *Harrington*, and in the heavy timber in the northeast part of Spring Valley, Fillmore county, *Winchell.*

LARIX, Tourn. LARCH.

L. Americana Michx. American or Black Larch. Tamarack. Hackmatack.

Abundant through the north half of the state, and common southeast to Wright, Hennepin and Ramsey counties; rare farther southeast, as on Pine creek in Houston county, *Winchell;* absent southwestward. This tree occurs in swamps, which are generally frequent, varying in extent from a few rods to several miles. *Mr. Nathan Butler* states that such swamps, bearing tamarack but scarcely any other trees, occupy nearly the entire country between Red lake and the lake of the Woods; and *Mr. G. M. Dawson* and others give a similar description of the area crossed by the international boundary between the lake of the Woods and the Red river valley. Tamarack also often grows on drier, hard ground; sometimes, north of lake Superior, attaining a hight of 90 or 100 feet (but very slender, having a diameter of only about one foot; valuable for railroad ties), *Clark.* Its usual hight is from 20 to 40 feet.

Watab river and township bear the name which the Chippewas give to the long threads obtained by splitting tamarack roots, used by them in sowing their birch canoes. *Keating's Narrative of Long's Expedition*, vol. ii, p. 73.

THUYA (Thuja), Tourn. ARBOR VITÆ.

T. occidentalis, L. American Arbor Vitæ. "White Cedar."

Common northeastward, forming almost impenetrable "cedar swamps," often attaining a large size, from 40 to 70 feet in hight, and from one to two or even three feet in diameter, *Clark, Roberts*; extending west to the south end of lake Winnipeg, *Bell*, the lake of the Woods and Roseau river, Red and Pemidji lakes, and to the head of Straight river in northeastern Becker county, and south to the south shore of Mille Lacs and the mouth of Snake river. It also occurs very rarely farther southeast, as on Gwinn's bluff in southeastern Winona county, *Winchell.* On the north shore of lake Superior, "not so common as inland, but maintains its hold upon life in the most unfavorable positions. Often the only representative of the vegetable kingdom on a bare rock in the lake, where its stem and branches plainly indicate the direction of the prevailing winds and waves." *Juni.* This tree is the principal species upon a large area adjoining the Mississippi river in northern Aitkin county. Its wood is light and very durable, being especially sought for fence and telegraph posts. It is often spiral-grained.

JUNIPERUS, L. JUNIPER.

J. communis, L. Common Juniper.

Throughout the state, but infrequent. Minnesota Point, near Duluth (plentiful), also near Minneapolis, *Roberts;* Wadena and Benton counties (rare), *Upham;* Sherburne and Ramsey counties, *Kelley;* Hennepin county, *Simmons;* Goodhue county, *Sandberg;* southeastern Winona county. *Winchell;* Dodge county, *Harrington*; Blue Earth county, *Leiberg;* bluffs of the Cottonwood river, *Juni.*

J. communis, L., var. **alpina,** Gaud. Juniper.

North shore of lake Superior, *Juni*; Taylor's Falls, *Miss Cathcart.* North.

J. Virginiana, L. Red Cedar. Red Savin.

Rainy Lake river, *Dawson;* upper Mississippi (rare), *Nicollet, Garrison;* lake Pepin, *Miss Manning;* bluffs of the Cottonwood river, *Juni*; at Redwood Falls. perhaps furnishing the name of the Redwood river. (Also see Cornus stolonifera.) Found scantily in exposed situations, as on the bluffs or shores of rivers and lakes, growing to be 10 to 25 feet high, in the greater part of the state; most frequent in its southeast quarter; absent, or rare, near its west side and north of lake Superior.

J. Sabina, L., var. **procumbens,** Pursh. Savin. Juniper.

Lake of the Woods, *Dawson;* plentiful on dunes at Sand Hill river, Garfield, Polk county, *Upham;* near Itasca lake, *Garrison;* Rice county, *Sperry;* bluffs of Le Sueur river, *Leiberg*; Olmsted county (rare), *Harrington;* the Big Woods, and Fillmore, Winona and Houston counties (rare), *Winchell.* North.

TAXACEÆ. Yew Family.

TAXUS, Tourn. Yew.

T. Canadensis, Willd. (T. baccata, L., var. Canadensis, Gray.) American Yew. Ground Hemlock.

Abundant north of lake Superior, *Juni, Roberts;* common, or frequent, thence west and south to nearly the same limits as the pines, black spruce and balsam fir; near Lake City, *Mrs. Ray.*

ARACEÆ. Arum Family.

ARISÆMA, Martius. Indian Turnip. Dragon-Arum.

A. triphyllum, Torr. (A. atrorubens, Blume. *Bot. Gazette*, ix, 114.) Indian Turnip. Jack-in-the-Pulpit.

Common, or frequent, throughout the state.

A. Dracontium, Schott. Green Dragon. Dragon-root.

Lake Pepin, *Miss Manning.* Rare. Southeast.

CALLA, L. Water Arum. Calla.

C. palustris, L. Water Arum. Wild Calla.

Common in the north half of the state, and southeast to Minneapolis and Saint Paul; rare farther southeast, as near lake Pepin, *Miss Manning;* absent southwestward.

SYMPLOCARPUS, Salisb. Skunk Cabbage.

S. fœtidus, Salisb. Skunk Cabbage.

Chisago county, etc. (common), *Upham*; Stillwater, *Miss Field*; Saint Paul, *Kelley;* near Minnehaha falls, *Roberts;* lake Pepin, *Miss Manning;* Winona county, *Holzinger;* New Ulm, *Juni.* [Hesper, Iowa, *Mrs. Carter;* lake Superior, *Whitney.*]

ACORUS, L. SWEET FLAG. CALAMUS.

A. Calamus, L. Sweet Flag. Calamus.

Common, or frequent, throughout the state; excepting perhaps southwestward, in which direction it extends at least to Redwood Falls, *Miss Butler*, and Emmet county, Iowa (rare), *Cratty*.

LEMNACEÆ. DUCKWEED FAMILY.

LEMNA, L. DUCKWEED. DUCK'S-MEAT.

L. trisulca, L. Duckweed. Duck's-meat.

Throughout the state. Minnesota river, *Parry;* Blue Earth county (flowering plentifully in 1882), *Leiberg;* frequent in Martin county, and in Emmet county, Iowa, *Cratty;* Minneapolis, *Arthur*, *Roberts*; Taylor's Falls, *Mrs. Ray;* Pembina, *Chickering;* Red river prairie and lake of the Woods, *Dawson*.

L. minor, L. Duckweed. Duck's-meat.

Throughout the state. Blue Earth county, *Leiberg;* Minneapolis, *Arthur*, *Simmons;* Duluth harbor (plentiful), *Roberts;* also, Red river prairie and lake of the Woods (common), *Dawson*.

SPEIRODELA, Schleid. DUCKWEED. DUCK'S-MEAT.

S. polyrrhiza, Schleid. (Lemna polyrrhiza, L.) Duckweed. Duck's-meat.

Throughout the state. Blue Earth county, *Leiberg;* frequent in Martin county, and in Emmet county, Iowa, *Cratty;* Minneapolis (abundant), *Arthur*, *Upham;* Saint Paul, *Kelley;* and northwest to the Saskatchewan river.

WOLFFIA, Horkel, Schleid. WOLFFIA.

W. Columbiana, Karsten. Wolffia.

Found by *Mr. Leiberg* in a pond at the southwest edge of the village of South Bend, Blue Earth county; plentiful, covering the surface to a depth of one or two inches in the summer; often blown upon the shore in small ridges by storms; slightly spreading to adjacent ponds; determined by *Dr. Engelmann*, who thinks that it is not a native of these northern latitudes, but has been probably brought by water-fowls. It appears to have become thoroughly acclimated in this locality.

TYPHACEÆ. CAT-TAIL FAMILY.

TYPHA, Tourn. CAT-TAIL FLAG.

T. latifolia, L. Common Cat-tail. Reed-mace.

Common throughout the state.

SPARGANIUM, Tourn. BUR-REED.

S. eurycarpum, Engelm. Bur-reed.

Throughout the state. Lake of the Woods, *Dawson;* Minneapolis (common), *Roberts;* West Saint Paul, *Miss Butler;* Wabasha, *Gibson;* Blue Earth county, *Leiberg;* Redwood Falls, *Pemberton;* Emmet county, Iowa (rare), *Cratty*.

S. simplex, Hudson. Bur-reed.

Red river valley, at Pembina, *Chickering;* Agate bay, lake Superior, *Juni;* West Saint Paul, *Miss Butler*; lake Pepin, *Miss Manning*.

S. simplex, Hudson, var. **Nuttallii,** Gray. Bur-reed.
St. Croix river, *Parry.*

S. simplex, Hudson, var. **androcladum,** Gray. Bur-reed.
Freeborn county, *Upham.*

S. simplex, Hudson, var. **angustifolium,** Gray. Bur-reed.
Lapham. North. [Isle Royale, *Whitney.*]

S. minimum, Bauhin. Bur-reed.
Brooks, St. Croix river, *Parry;* lake of the Woods, *Dawson.* [North of lake Superior, *Agassiz;* Isle Royale, *Whitney.*] North.

NAIADACEÆ. PONDWEED FAMILY.

NAIAS, L. NAIAD.

N. flexilis, Rostk. & Schmidt. Naiad.
Throughout the state. Blue Earth county, *Leiberg;* plentiful in Martin county and in Emmet county, Iowa, *Cratty;* Minneapolis (abundant), *Miss Butler.* [Manitoba, *Macoun.*]

ZANNICHELLIA, Micheli. HORNED PONDWEED.

Z. palustris, L. Horned Pondweed.
Peat-bogs between Kasota and Mankato, *Leiberg.* Rare.

POTAMOGETON, Tourn. PONDWEED. POTAMOGETON.

P. natans, L. Pondweed.
Common, or frequent, throughout the state.

P. Claytonii, Tuckerman. Pondweed.
Plentiful near Stewart river, north of lake Superior, *Roberts.*

[P. rufescens, Schrader, will probably be found in northeastern Minnesota.]

P. lonchites, Tuckerm. Pondweed.
Le Sueur river, Blue Earth county, *Leiberg;* Emmet county, Iowa (frequent), *Cratty.* South.

P. amplifolius, Tuckerman. Pondweed.
Plentiful in Devil's Track lake, north of lake Superior, *Roberts;* lake Pepin, *Miss Manning;* Emmet county, Iowa (rare), *Cratty.*

P. gramineus, L., var. **heterophyllus,** Fries. Pondweed.
Throughout the state. Abundant in Devil's Track lake, *Roberts;* frequent in Emmet county, Iowa, *Cratty.*

P. lucens, L. Pondweed.
Throughout the state, but infrequent. Lake Minnetonka, *Roberts;* White Bear lake, Ramsey county, *Simmons;* Stearns county, *Campbell.* [North of lake Superior, *Agassiz;* Manitoba, *Macoun.*]

P. lucens, L., var. **minor,** Nolte. Pondweed.
Lake Minnetonka, *Herrick, Roberts.*

[P. prælongus, Wulfen., will doubtless be found in Minnesota.]

P. Illinoensis, Morong.* Pondweed.

Emmet county, Iowa, *Cratty, Arthur;* doubtless also to be found in southern Minnesota.

P. perfoliatus, L. Pondweed.

Throughout the state. Blue Earth county, *Leiberg;* lake Calhoun, Minneapolis, *Upham;* Stearns county, *Campbell;* lake of the Woods, *Dawson.*

P. perfoliatus, L., var. **lanceolatus,** Robbins. Pondweed.

Also throughout the state. Lake Minnetonka, *Arthur;* frequent in Martin county, and in Emmet county, Iowa, *Cratty.*

P. zosteræfolius, Schum. (P. compressus, Fries, not L.) Pondweed.

Minneapolis, *Simmons;* Blue Earth county, *Leiberg,* and Martin county (frequent), *Cratty,* both determined by *Rev. T. Morong.*

P. pauciflorus, Pursh. Pondweed.

Minneapolis (common), *Miss Butler;* lake Pepin, *Miss Manning;* Blue Earth county, *Leiberg,* determined by *Rev. T. Morong;* Emmet county, Iowa (frequent), *Cratty.* [North of lake Superior, *Agassiz.*]

P. pusillus, L. Pondweed.

Throughout the state. Lake of the Woods, *Dawson;* White Bear lake, Ramsey county, *Simmons;* Emmet county, Iowa, *Cratty,* determined by *Rev. T. Morong.*

P. pusillus, L., var. **major,** Fries. Pondweed.

Martin county (frequent), *Cratty,* determined by *Rev. T. Morong.*

P. pusillus, L., var. **vulgaris,** Fries. Pondweed.

Lake Minnetonka (plentiful), *Herrick, Roberts;* Winona lake, *Holzinger.*

P. pectinatus, L. Pondweed.

Throughout the state. Mississippi river near Saint Cloud, *Campbell;* Blue Earth county, *Leiberg;* Martin county (abundant), *Cratty,* determined by *Rev. T. Morong.* [North of lake Superior, *Agassiz;* James river, Dakota, *Geyer.*]

ALISMACEÆ. WATER-PLANTAIN FAMILY.

TRIGLOCHIN, L. ARROW-GRASS. (This genus and SCHEUCHZERIA are included in the preceding order, NAIADACEÆ, by *Watson* in the *Botany of California.*)

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*POTAMOGETON ILLINOENSIS, Morong. Stem stout, branching towards the summit; floating leaves opposite, thick, coriaceous, oval or ovate, 2 to 3 inches long by 1½ broad, 19- to 23-nerved, rounded or sub-cordate at base, and with a short blunt point at the apex, on short petioles; submersed leaves comparatively few, dark green, oblong-elliptical, acute at each end, usually ample (the largest nearly 8 inches long and 1½ wide), entire, rarely mucronate, nearly or quite sessile, the uppermost opposite; stipules coarse, free, obtuse, strongly bicarinate, about 2 inches in length; peduncles often clustered at the summit of the stem, 2 to 4 inches long, usually somewhat thickening upwards; spikes about 2 inches long, densely flowered; fruit roundish obovate, 1¾ to 2 lines long and 1 to 1½ lines wide, 3-keeled on the back, the middle keel prominent and sometimes shouldered at the top, flattened and slightly impressed on the sides, obtuse or occasionally pointed at the base, the style short and nearly facial, the apex of the embryo pointing transversely inwards. Allied to P. lucens, L., in habit, but with larger fruit, and in foliage quite distinct. *Morong* in *Botanical Gazette,* vol. v, p. 50 (May, 1880).

T. palustre, L. Arrow-grass.

Throughout the state. Peat-bogs between Kasota and Mankato (plentiful), *Leiberg;* Red river valley, *Scott.*

T. maritimum, L. Arrow-grass.

Lapham. Stearns county, *Campbell.* [Sheyenne river and Devil's lake, Dakota, *Geyer.*] North.

T. maritimum, L., var. **elatum**, Gray. Arrow-grass.

Duluth (common), and Minneapolis (frequent), *Roberts;* Chisago county, *Upham;* upper Minnesota river, *Parry;* also, peat-bogs between Kasota and Mankato (plentiful), *Leiberg;* Emmet county, Iowa (rare), *Cratty.*

SCHEUCHZERIA, L. SCHEUCHZERIA.

S. palustris, L. Scheuchzeria.

St. Croix river, *Parry;* near Clearwater, Wright county, *Mrs. Terry;* Minneapolis, *Kassube,* (lake Calhoun) *Miss Butler;* Emmet county, Iowa (rare), *Cratty.*

ALISMA, L WATER-PLANTAIN.

A. Plantago, L. Water-Plantain.

Common throughout the state. "Very variable as respects foliage, the forms being determined chiefly by the place of growth and not deserving to rank as varieties." *Watson, Botany of California.*

ECHINODORUS, Richard, Engelmann. ECHINODORUS.

E. parvulus, Engelm. Echinodorus.

Muddy margins of ponds, St. Croix, *Parry.* [North of lake Superior, *Agassiz.*]

SAGITTARIA, L. ARROW-HEAD.

S. variabilis, Engelm. Common Arrow-head.

Common (especially the var. hastata, Gray) throughout the state ; var. angustifolia, Gray, Minneapolis, *Miss Butler.* "This plant, so variable in foliage, and so abundant in distribution, furnishes an important article of native food in the tubers which beset its fibrous roots. These tubers (from the fact of their affording nourishment to the larger aquatic fowls which congregate in such abundance about the northwestern lakes) are called by the Chippewas, Wab-es-i-pin-ig, or swan potatoes, a name which has been naturally appropriated to several streams of this region, Wabesipinicon ; meaning, the abode of the swan potato. These tubers frequently attain the size of a small hen's-egg, and are then eaten by the Indians, with whom they are a great favorite. In their raw state they contain a bitter, milky juice, but in boiling become sweet and palatable." *Parry.*

S. heterophylla, Pursh. Arrow-head.

Upper Mississippi river, *Houghton;* Hennepin county, *Roberts, Griswold;* probably extending through the south half of the state.

S. graminea, Michx. Arrow-head.

Minneapolis, *Kassube.* South.

S. cristata, Engelm.* Arrow-head.

Emmet county, Iowa, on the south boundary of Minnesota, *Cratty;* doubtless also in this state.

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* SAGITTARIA CRISTATA, Engelm. Flowers only of the lowest whorl fertile ; fruit-heads much larger than in S. graminea ; achenia broad, with a conspicuous horizontal

HYDROCHARIDACEÆ. FROG'S-BIT FAMILY.

ANACHARIS, Richard. WATER-WEED.

A. Canadensis, Planchon. Water-weed.

Common throughout the state. Duluth harbor (plentiful), and Minneapolis, *Roberts;* lake Minnetonka, *Miss Butler;* Winona lake, *Holzinger;* Blue Earth county, *Leiberg;* plentiful in Martin county, and in Emmet county, Iowa, *Cratty.* This aquatic plant, common, but nowhere troublesome, in this its native country, having become naturalized in Europe, grows there more rankly, so as to become in many places a serious obstruction to river-navigation. Since 1836, when it first appeared in England and Ireland, it has spread eastward upon the continent along the rivers of Belgium, Holland and Germany, and is now complained of at Riga in western Russia. *Popular Science Monthly,* vol. xix, p. 430 (July, 1881).

VALLISNERIA, Micheli. TAPE-GRASS. EEL-GRASS.

V. spiralis, L. Tape-grass. Eel-grass.

With the preceding, in Duluth harbor (plentiful), and Minneapolis, *Roberts,* (lake Calhoun) *Miss Butler;* Blue Earth county, *Gedge,* (Eagle lake) *Leiberg;* Redwood Falls, *Miss Butler.*

ORCHIDACEÆ. ORCHIS FAMILY.

ORCHIS, L. ORCHIS.

O. spectabilis, L. Showy Orchis.

Duluth (frequent), and Saint Paul (rare), *Miss Cathcart;* Stearns county, *Campbell;* Fergus Falls, *Leonard;* Minneapolis (frequent), *Roberts;* Northfield, *Chaney;* Faribault, *Miss Beane;* Blue Earth county, *Leiberg;* frequent at Hesper, Iowa, *Mrs. Carter.*

O. rotundifolia, Pursh. (Habenaria rotundifolia, Richardson.) Orchis.

Detroit, Becker county, *Gedge.* Rare. North.

HABENARIA, Willd. REIN-ORCHIS.

H. tridentata, Hook. Rein-Orchis.

Lapham. Goodhue county, *Sandberg.* [North of lake Superior, *Agassiz.*] Infrequent.

H. virescens, Spreng. Greenish Orchis.

Lake City, *Miss Manning;* Goodhue county, *Sandberg;* Minneapolis, *Roberts;* Stearns county, *Campbell;* Detroit, Becker county, *Gedge.* Infrequent.

H. viridis, R. Br., var. **bracteata,** Reich. Bracted Green Orchis.

Throughout the state. Carlton's Peak, north of lake Superior, and also near Minneapolis, *Roberts;* eastern border of Red river prairie, *Dawson;* Stearns county, *Campbell;* lake Elmo, Washington county, *Leonard;* Blue Earth county, *Leiberg;* Faribault, *Miss Beane;* Winona county, *Holzinger.* [Hesper, *Mrs. Carter,* and south to Council Bluffs, Iowa, *Geyer.*]

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style, and crested back and sides. . . . Near S. graminea, Michx., and perhaps only a variety of it, although the only other Sagittaria with such crests to the achenia is S. natans, Michx. Further observations are needed to eventually place it correctly. *Letter of Dr. Engelmann,* dated March 15th, 1882, in *Arthur's Contributions to the Flora of Iowa, No. V.*

H. hyperborea, R. Br. Northern Green Orchis.

Throughout the state. Lake Superior, *Whitney;* lake of the Woods, *Dawson;* Detroit, Becker county, *Gedge;* Stearns county, *Campbell;* Minneapolis (common), *Roberts;* Hesper, Iowa (rare), *Mrs. Carter.*

H. dilatata, Gray. Rein-Orchis. Northern White Orchis.

Lake Superior, *Whitney;* Detroit, *Gedge;* Minneapolis (common), *Roberts;* St. Croix river, *Parry.* North.

[H. rotundifolia, Richardson, is found to belong to the preceding genus, Orchis.]

H. obtusata, Richardson. Rein-Orchis.

Abundant north of lake Superior, *Juni, Roberts.* North.

H. Hookeri, Torr. Small Two-leaved Orchis.

Throughout the state. St. Croix river, *Parry;* Elk River, Sherburne county, *Campbell;* Saint Paul, *Miss Cathcart;* Winona county, *Holzinger;* Hesper, Iowa, *Mrs. Carter.* [Lake Superior, *Whitney;* Manitoba, *Macoun.*]

H. orbiculata, Torr. Large Round-leaved Orchis.

North of lake Superior, *Juni, Roberts;* St. Louis river, *Mrs. Herrick.* Northeast.

H. blephariglottis, Hook., var. **holopetala,** Gray. White Fringed-Orchis.

Minnesota Point, near Duluth, *Miss Cathcart.* Rare.

H. leucophæa, Gray. Western Greenish Fringed-Orchis.

Frequent in the south half of the state, extending north at least to Alexandria, *Mrs. Terry,* and Clay county, in the Red river valley, *Upham.* Sometimes almost pure white. It has spread widely in Martin county during the past six or seven years, being now very common in some parts of the county, *Gedge.*

H. lacera, R. Br. Ragged Fringed-Orchis.

Minneapolis, *Roberts;* Goodhue county, *Sandberg.* South.

H. psycodes, Gray. Purple Fringed-Orchis.

Frequent throughout the state.

GOODYERA, R. Br. RATTLESNAKE-PLANTAIN.

G. repens, R. Br. Rattlesnake-Plantain.

North of lake Superior (common), also at Minneapolis, *Roberts;* St Croix Falls, *Miss Field.* North.

G. pubescens, R. Br. Rattlesnake-Plantain.

North of lake Superior, *Juni;* Taylor's Falls, *Miss Cathcart, Roberts;* Clearwater, Wright county, *Mrs. Terry;* Cannon River Falls, *Blake, Sandberg.*

G. Menziesii, Lindl. Rattlesnake-Plantain.

Isle Royale, *Dr. A. B. Lyons;* doubtless also in Minnesota north of lake Superior.

SPIRANTHES, Richard. LADIES' TRESSES.

S. latifolia, Torr. Ladies' Tresses.

Lapham. Hills of Zumbro river, *Geyer.* Rare. Southeast.

S. Romanzoffiana, Chamisso. Ladies' Tresses.

North shore of lake Superior, *Juni;* Polk county, *Upham;* Clay county, *Gedge;* Stearns county, *Campbell;* Minneapolis, *Roberts;* Cottonwood county, *Holzinger;* peat-bog between Kasota and Mankato (very scarce), *Leiberg.* North.

S. cernua, Richard. Ladies' Tresses.

Common, or frequent, through the south half of the state, and perhaps northward;

lake Superior, *Whitney*, and lake of the Woods, *Dawson;* var. latifolia, Torr., hills of Zumbro river, *Geyer*.

S. gracilis, Bigelow. Ladies' Tresses.

Throughout the state, but infrequent. Pine barrens, St. Croix river, *Parry;* Stearns county, *Campbell;* Minneapolis, *R. S. Williams*, *Roberts*; lake Pepin, *Miss Manning*. [Decorah, Iowa, *Arthur;* Nebraska, *Aughey*; Manitoba, *Macoun*.]

LISTERA, R. Br. TWAYBLADE.

L. cordata, R. Br. Twayblade.

Between lake Superior and the lake of the Woods, *Macoun;* Isle Royale, *Dr. A. B. Lyons*. North.

L. convallarioides, Nutt. Twayblade.

Also, between lake Superior and the lake of the Woods, *Macoun;* Isle Royale, *Dr. A. B. Lyons*. North.

ARETHUSA, Gronov. ARETHUSA.

A. bulbosa, L. Arethusa.

Chisago county, *Upham;* Ramsey county (near lake Johanna), *Roberts;* Red Wing, *Sandberg*. Rare. North.

POGONIA, Juss. POGONIA.

P. ophioglossoides, Nutt. Pogonia.

St. Croix river, *Parry*; Isanti county, *Upham;* Stearns county, *Campbell;* Saint Paul, *Mrs. Terry*, *Kelley;* Minneapolis (frequent), *Roberts*, *Miss Butler*.

[P. pendula, Lindl., and P. verticillata, Nutt., should be looked for in this state.]

CALOPOGON, R. Br. CALOPOGON. GRASS PINK.

C. pulchellus, R. Br. Calopogon. Grass Pink.

Common, or frequent, throughout the state.

CALYPSO, Salisb. CALYPSO.

C. borealis, Salisb. Calypso.

Black Point, north shore of lake Superior, *Roberts;* Duluth, *Miss Cathcart*. Rare. North.

MICROSTYLIS, Nutt. ADDER'S-MOUTH.

M. monophyllos, Lindl. Adder's-Mouth.

Lapham. St. Croix river, *Parry;* Taylor's Falls, *Roberts*. Rare. North.

M. ophioglossoides, Nutt. Adder's-Mouth.

Itasca lake, *Houghton;* Mille Lacs, *Campbell;* St. Croix river, *Parry*; at head of lake Pepin, *Sandberg;* Hesper, Iowa (rare), *Mrs. Carter*. [Manitoba, *Macoun*.]

LIPARIS, Richard. TWAYBLADE.

L. liliifolia, Richard. Twayblade.

Minneapolis (one mile west of city), *Roberts;* near Saint Paul, *Mrs. Terry*; Goodhue county, *Sandberg;* Winona county, *Holzinger;* Hesper, Iowa, *Mrs. Carter*. Rare.

L. Lœselii, Richard. Twayblade.

In tamarack swamps near Minneapolis, *Roberts;* Stearns county, *Campbell*. Rare.

CORALLORHIZA, Haller. CORAL-ROOT.

C. innata, R. Br. Coral-root.

Stearns county, *Campbell;* along the northern boundary of Minnesota, *Macoun.* Throughout the state: rare southward, frequent northward.

C. multiflora, Nutt. Coral-root.

Hesper, Iowa, *Mrs. Carter;* Taylor's Falls, *Roberts*; Stearns county, *Campbell;* Pembina, *Havard;* lake Superior, *Whitney*. Throughout the state, but infrequent.

C. Macræi, Gray. Coral-root.

Lapham. [Mackinaw (abundant), *Whitney.*] Rare in Minnesota.

APLECTRUM, Torrey. PUTTY-ROOT. ADAM-AND-EVE.

A. hiemale, Torr. Putty-root. Adam and Eve.

St. Croix Falls, *Miss Field;* Saint Paul, *Miss Cathcart;* Hastings, *Mrs. Ray;* Faribault, *Miss Beane;* in woods at the head of Van Brunt slough, Mankato, *Leiberg*. [Manitoba, *Macoun.*] Rare.

CYPRIPEDIUM, L. LADY'S-SLIPPER. MOCCASIN-FLOWER.

C. arietinum, R. Br. Ram's-head Lady's-Slipper.

Clearwater lake, in the northwest part of Wright county, *Mrs. Terry;* Stearns county, *Campbell;* Detroit, Becker county, *Gedge.* Rare. North.

C. candidum, Muhl. Small White Lady's-Slipper.

Through the south half of the state, mostly infrequent and local. Winona county, *Holzinger;* lake Pepin, *Miss Manning;* Cannon River Falls, *Blake, Sandberg;* Minneapolis, *Roberts*, (lake Harriet) *Mrs. Terry;* Anoka county, also New Ulm, *Juni;* Faribault, *Miss Beane;* Nicollet county, *Leiberg;* Emmet county, Iowa (plentiful), *Cratty;* extending north at least to Morrison county, *Miss Babbitt*, the upper Mississippi river, *Garrison*, and Fergus Falls, *Leonard.*

C. parviflorum, Salisb. Smaller Yellow Lady's-Slipper.

Frequent throughout the state, excepting far southward.

C. pubescens, Willd. Larger Yellow Lady's-Slipper.

Common, or frequent, throughout the state.

C. spectabile, Swartz. Showy Lady's-Slipper.

Common, or frequent, often growing on dryish hard land, throughout the state; excepting perhaps far northeastward, in which direction it extends at least to the St. Louis river, *Mrs. Herrick*, the upper Mississippi river, *Garrison*, Detroit, Becker county (abundant), *Gedge*, and Pembina, *Havard.*

C. acaule, Ait. Stemless Lady's-Slipper.

Frequent through the north half of the state; extending south to Saint Paul, *Miss Cathcart*, Minneapolis (in tamarack swamps), *Roberts*, and Martin county, *Gedge.*

AMARYLLIDACEÆ. AMARYLLIS FAMILY.

HYPOXYS, L. STAR-GRASS.

H. erecta, L. Star-grass.

Common through the south half of the state and in the Red river valley; extending northeast to the upper Mississippi river.

HÆMODORACEÆ. BLOODWORT FAMILY.

ALETRIS, L. COLIC-ROOT. STAR-GRASS.

A. farinosa, L. Colic-root. Star-grass.
Lapham. Rare. Southeast.

IRIDACEÆ. IRIS FAMILY.

IRIS, Tourn. FLOWER-DE-LUCE. IRIS.

I. versicolor, L. Larger Blue Flag.
Common. or frequent, throughout the state.

SISYRINCHIUM, L. BLUE-EYED GRASS.

S. angustifolium, Miller. (S. Bermudiana, L., in part; see *American Naturalist*, vol. xviii, pp. 623-5; June, 1884.) Blue-eyed Grass.

This variable species (in the varieties anceps and mucronatum, with intermediate forms) is found throughout the state, being usually abundant in all the prairie region. The var. albidum occurs infrequently at Marine, Washington county, *Miss Field*, Minneapolis, *Roberts*, *Kassube*, and southwestward.

DIOSCOREACEÆ. YAM FAMILY.

DIOSCOREA, Plumier. YAM.

D. villosa, L. Wild Yam-root.

Common, or frequent, through the south part of the state; extending north to Saint Paul, *Roberts*, Minneapolis, *Kassube*, (lake Calhoun) *W. H. Hatch*, Anoka county, *Juni*, and the north side of Snake river east of Chengwatana, Pine county, *Upham*.

SMILACEÆ. SMILAX FAMILY.

SMILAX, Tourn. GREENBRIER. CATBRIER.

S. rotundifolia, L. Common Greenbrier.

Lake Superior to the Mississippi, *Houghton;* Stearns county, *Mrs. Blaisdell;* Anoka county, *Juni;* Minneapolis (common), *Roberts*, *Upham;* Minnesota river, *Parry;* Faribault, *Miss Beane;* Goodhue county, *Sandberg;* lake Pepin, *Miss Manning;* Houston county, *Winchell*.

S. hispida, Muhl. Greenbrier. Catbrier.

Minnesota river, *Parry;* Blue Earth county, *Leiberg;* frequent in Martin county, and in Emmet county, Iowa, *Cratty;* Kanabec county, *Upham*.

S. herbacea, L. Carrion-Flower.

Common, or frequent, throughout the state.

S. herbacea, L., var. **pulverulenta,** Gray. Carrion-Flower.

Vicinity of Hesper, Iowa, on the southern border of Houston and Fillmore counties, *Mrs. Carter;* Lake City, *Mrs. Ray;* Faribault, *Miss Beane*.

LILIACEÆ. LILY FAMILY.

TRILLIUM, L. TRILLIUM. THREE-LEAVED NIGHTSHADE. WAKE-ROBIN.

T. sessile, L. Trillium. Three-leaved Nightshade. Wake-Robin.
Saint Paul, *Miss Cathcart.* Southeast.

T. recurvatum, Beck. Trillium. Thre-leaved Nightshade.
Lake Pepin, *Miss Manning.* Southeast.

T. grandiflorum, Salisb. Large White Trillium or Wake-Robin.
Frequent northward; extending southeast to lake Pepin, *Miss Manning*, Northfield, Rice county, *Chaney*, and Blue Earth county, *Gedge*.

T. erectum, L. Purple Trillium or Birthroot. Bath Flower.
Lapham. Blue Earth county, *Leiberg;* Saint Paul, *Miss Cathcart;* Minneapolis, *Simmons.* Rare. (Watson's *Revision of the North American Liliaceæ* makes this name include also the two following, which, however, are retained here as in Gray's *Manual.*)

T. erectum, L., var. **album**, Pursh. Trillium. Birthroot.
Winona, *Holzinger;* Marine, Washington county, *Miss Field;* Stearns county, *Garrison.* Rare.

T. erectum, L., var. **declinatum**, Gray. Trillium. Birthroot.
Frequent, in some localities plentiful, throughout the state.

T. cernuum, L. Nodding Trillium or Wake-Robin.
Common, or frequent, throughout most of the state; extending north at least to Grand Marais, *Roberts*, and the upper Mississippi river, *Garrison;* and west to Fergus Falls, *Leonard*, and Redwood Falls, *Pemberton*.

T. nivale, Riddell. Dwarf White Trillium. Snowy Trillium.
Winona, *Holzinger;* lake Pepin, *Miss Manning;* near South Bend, Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty.* Rare. South.

MEDEOLA, Gronov. INDIAN CUCUMBER-ROOT.

M. Virginiana, L. Indian Cucumber-root.
Lapham. Near Saint Paul, *Mrs. Terry;* Lake City, *Mrs. Ray.* Infrequent. Southeast.

MELANTHIUM, L. MELANTHIUM.

M. Virginicum, L. Bunch-flower.
Minneapolis (near lake Calhoun), *Mrs. Terry.* Rare. Southeast.

ZYGADENUS, Michx. ZYGADENE.

Z. elegans, Pursh. (Z. glaucus, Nutt.) Zygadene. "Alkali-Grass."
Common, often abundant, throughout the west part of the state; frequent eastward to the upper Mississippi river, Sauk Center, and Nicollet and Steele counties; rare farther east in Benton county, at Minneapolis, Castle Rock, Dakota county, Cannon River Falls, Goodhue county, and lake Pepin.

VERATRUM, Tourn. FALSE HELLEBORE.

V. viride, Ait. American White Hellebore. Indian Poke.
Stearns county, *Garrison.* Infrequent. North.

TOFIELDIA, Hudson. FALSE ASPHODEL.

T. palustris, Hudson. False Asphodel.

Isle Royale and Thunder bay; doubtless also on the north shore of lake Superior in Minnesota.

T. glutinosa, Willd. False Asphodel.

Stillwater, *Parry*; Minneapolis, *Roberts*, *Miss Butler;* Fergus Falls, *Leonard;* common in the Red river valley, *Upham.*

UVULARIA, L. BELLWORT.

U. grandiflora, Smith. Large-flowered Bellwort.

Common, or frequent, through the south half of the state and in the Red river valley,

U. perfoliata, L. Mealy Bellwort.

Frequent in the south half of the state; extending north at least to St. Croix Falls, *Miss Field*, Stearns county, *Campbell*, and the Sisseton Agency, Dakota, *Upham.*

OAKESIA, Watson. BELLWORT. OAKESIA.

O. sessilifolia, Watson. (Uvularia sessilifolia, L.) Sessile-leaved Bellwort.

Throughout the state. Morrison county, *Miss Babbitt;* Stearns county, *Campbell;* Fergus Falls, *Leonard;* Anoka county, etc., *Upham*; Minneapolis, *Twining*, *Roberts;* Saint Paul, *Miss Cathcart;* Northfield, Rice county, *Chaney.* [Manitoba, *Macoun;* Nebraska, *Aughey.*]

STREPTOPUS, Michx. TWISTED-STALK.

S. amplexifolius, DC. Twisted-Stalk.

North of lake Superior, *Juni;* Taylor's Falls, *Miss Cathcart;* bluffs near (south of) Saint Paul, *Mrs. Terry.* Rare. North.

S. roseus, Michx. Twisted-Stalk.

Common north of lake Superior, *Roberts;* Benton county, *Upham*; bluffs south of Saint Paul, *Mrs. Terry.* North.

CLINTONIA, Raf. CLINTONIA.

C. borealis, Raf. Northern Clintonia.

Abundant northeastward; extending west to the Winnipeg valley, *Watson*, the sources of the Mississippi, *Houghton*, and Wadena county. *Upham;* and south to Kanabec county (common), Stearns county, *Campbell*, Minneapolis (rare), *Roberts*, Saint Paul, *Miss Cathcart*, and the Wisconsin side of lake Pepin, *Mrs. Ray.*

SMILACINA, Desf. FALSE SOLOMON'S SEAL.

S. racemosa, Desf. False Spikenard. False Solomon's Seal.

Common, or frequent, throughout the state.

S. stellata, Desf. False Solomon's Seal.

Also common, or frequent, throughout the state.

S. trifolia, Desf. Three-leaved False Solomon's Seal.

Frequent through the north half of the state; extending south at least to Minneapolis, *Roberts*, and Fergus Falls, *Leonard.*

MAIANTHEMUM, Weber. FALSE SOLOMON'S SEAL.

M. Canadense, Desf. (Smilacina bifolia, Ker., var. Canadensis, Gray.) Two-leaved False Solomon's Seal.

Common throughout the state.

POLYGONATUM, Tourn. SOLOMON'S SEAL.

P. biflorum, Ell. Smaller Solomon's Seal.

Frequent, occasionally common, throughout most of the state; extending north to lake Superior, *Whitney*, and Pembina, *Havard.*

P. giganteum, Dietrich. Great Solomon's Seal.

Frequent, or common, throughout the state. (*Mr. Lewis Foote* remarks that these species are not separable in their varying forms, but seem to constitute a single polymorphous species.)

ASPARAGUS, L. ASPARAGUS.

A. officinalis, L. *Garden Asparagus.*

Adventive: Minneapolis; Cannon River Falls; lake Pepin; Blue Earth county; New Ulm.

LILIUM, L. LILY.

L. Philadelphicum, L. Wild Orange-red Lily.

Generally common, or frequent, throughout the state; especially in Sherburne and Todd counties, in the Red river valley, and thence south to Iowa.

L. Canadense, L. Nodding Wild Yellow Lily.

Common throughout the east half of the state; less frequent in the Red river valley; rare southwestward.

L. superbum, L. Turk's-cap Lily. "Wild Tiger-Lily."

Upper Mississippi river, *Garrison;* Minneapolis, *Twining*, *Simmons*; Excelsior, Hennepin county, *Mrs. Terry*; Nicollet county, *Aiton;* Martin county, *Gedge*; Cannon River Falls, *Blake*, *Sandberg*; lake Pepin, *Miss Manning*; Hesper, Iowa, *Mrs. Carter*. Infrequent. South.

ERYTHRONIUM, L. ADDER'S-TONGUE. DOG'S-TOOTH VIOLET.

E. Americanum, Smith. Yellow Adder's-tongue or Dog's-tooth Violet.

Saint Paul, *Miss Cathcart;* Lake City, *Mrs. Ray;* Winona, *Holzinger;* plentiful locally near Hesper, Iowa, *Mrs. Carter*; Blue Earth county, *Leiberg*. [Lake Superior, *Whitney;* Nebraska, *Aughey.*] Infrequent. East and south.

E. albidum, Nutt. White Adder's-tongue or Dog's-tooth Violet.

Common, often abundant, southeastward; less frequent, or rare, southwestward; extending north to St. Croix Falls, *Miss Field*, Stearns county, *Campbell*, and Brown county, *Juni*.

E. propullans, Gray.* Adder's-tongue. Dog's-tooth Violet.

Faribault (abundant), *Miss Beane*; described and figured by *Professor Gray* in the *American Naturalist*, vol. v, pp. 298-300, July, 1871, from specimens "collected at Faribault, Minnesota, by *Mrs. Mary B. Hedges*, the teacher of botany in St. Mary's Hall."

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*ERYTHRONIUM PROPULLANS, Gray. The flower is much smaller than that of any other known species, being barely half an inch long; and its color, a bright pink or rose, like that of the European E. Dens-Canis, reflects the meaning of the generic name (viz., red), which is lost to us in our two familiar Adder-tongues, one with yellow, the other with white, blossoms. The most singular peculiarity of the new species is found in the way in which the bulb propagates. In E. Dens-Canis new bulbs are produced directly from the side of the old one, on which they are sessile, so that the plant as it multiplies forms close clumps. In our E. Americanum long and slender offshoots, or subterranean runners, proceed from the base of the parent bulb and develop the new bulb at their distant apex. Our western E. albidum does not differ in this respect. In the new species an offshoot springs from the ascending slender stem, or sub-

CAMASSIA, Lindl. QUAMASH.

C. Fraseri, Torr. (Scilla Fraseri, Gray.) Eastern Quamash. Wild Hyacinth.

Blue Earth county, *Leiberg;* Martin county, *Cratty.* South.

ALLIUM, L. ONION. GARLIC.

A. tricoccum, Ait. Wild Leek.

Throughout the state, excepting perhaps far northward; but mostly infrequent or rare. Minnesota and St. Croix rivers, *Parry*; upper Mississippi river, *Garrison*; Fergus Falls, *Leonard*; Minneapolis, *W. H. Hatch, Roberts;* Goodhue county, *Sandberg;* Blue Earth county, *Leiberg;* New Ulm, *Juni;* Martin and Nobles counties, *Gedge.* [Emmet county, Iowa (very rare), *Cratty*; lake Superior, *Whitney*.]

A. cernuum, Roth. Wild Onion.

Common throughout the prairie portion of the state; also found at the lake of the Woods, *Dawson.* (The umbel is reflexed until flowering, but then usually becomes erect.)

A. stellatum, Fras. Wild Onion.

Upper Minnesota river, *Geyer;* Tracy, Lyon county, *Gedge;* Minneapolis, *Griswold;* lake Pepin, *Miss Manning*; Stearns county, *Garrison;* Alexandria, *Mrs. Terry.* Rare.

A. reticulatum, Fras.* Wild Onion.

Red river valley, *Scott*, determined by *Mr. Sereno Watson.* West.

A. Schœnoprasum, L. Chives.

Northeastward, *Clark;* Stearns county, *Mrs. Blaisdell;* upper Mississippi river, *Garrison.* [Manitoba, *Macoun.*] North.

A. Canadense, Kalm. Wild Garlic.

Common or frequent, through the south part of the state: extending west to Worthington, *Foote*, and Pipestone county, *Mrs. Bennett*, and north to Minneapolis and Big Stone lake, *Upham.*

JUNCACEÆ. RUSH FAMILY.

LUZULA, DC. WOOD-RUSH.

L. pilosa, Willd. Wood-Rush.

Lake Pepin, *Miss Manning.* [Manitoba, *Macoun.*] Probably common northward.

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terranean sheathed portion of the scape (which is commonly five or six inches long), remote from the parent bulb, usually about mid-way between it and the bases or apparent insertion of the pair of leaves: this lateral offshoot grows downward, sometimes lengthening as in the foregoing species, sometimes remaining short, and its apex dilates into the new bulb. . . . Scape bulbiferous from its sheathed portion below the developed leaves; these oblong-lanceolate, acuminate, slightly mottled; perianth rose-purple or pink (half an inch long); the segments acute, all with a yellow spot but plane at the base, the inner like the outer destitute of either groove or tooth-like appendages, but a little more narrowed at base; anthers merely oblong; style hardly at all narrowed downward, entire, the small stigma even barely three-lobed; ovules few (4 to 6) in each cell. *Gray* in *American Naturalist*, vol. v.

*ALLIUM RETICULATUM, Fras. Coats densely fibrous; scape 3 to 8 inches high, subterete; leaves very narrowly linear, elongated; spathe usually 2-valved; umbel many-flowered, spreading: pedicels usually short (2 to 6 lines long); stamens and style shorter than the usually acute (3 to 4 lines long) white or slightly pinkish sepals; crest mostly short. *Watson's Revision of Allium* in *King's Expl. of the Fortieth Parallel*, and his *Revision of the North American Liliaceæ, Proc. Amer. Acad.*, xiv.

L. spadicea, DC., var. **melanocarpa,** Meyer. (L. parviflora, Desv., var. melanocarpa, Gray.) Wood-Rush.

Frequent along the northern boundary of Minnesota, *Macoun.*

L. campestris, DC. Wood-Rush.

Throughout the state. Upper Mississippi river, *Garrison*; Anoka county, etc. *Upham;* lake Pepin, *Miss Manning;* Emmet county, Iowa (very rare), *Cratty.*

JUNCUS, L. RUSH. BOG-RUSH.

J. effusus, L. Common or Soft Rush.

Throughout the state. *Lapham.* Lake Pepin, *Miss Manning.* [North of lake Superior, *Agassiz;* Manitoba, *Macoun.*]

J. filiformis, L. Bog-Rush.

Lapham. Lake Pepin, *Miss Manning.* [Manitoba, *Macoun;* Nebraska, *Aughey.*] Throughout the state, chiefly northward.

J. Balticus, Dethard. Bog-Rush.

Lapham. Pembina, *Chickering* ; Red river country generally, *Dawson.* [North of lake Superior, *Agassiz* ; Emmet county, Iowa (rare), *Cratty.*] Throughout the state, chiefly northward.

J. Balticus, Dethard, var. **montanus,** Engelm.* Bog-Rush.

Lake of the Woods, *Dawson, Macoun.* West.

J. bufonius, L. Bog-Rush.

Lake Pepin, *Miss Manning*; lake of the Woods, *Macoun.* [James river, Dakota, *Geyer.*] Infrequent.

[J. stygius, L., and J. Gerardi, Loisel, should be looked for in Minnesota north of lake Superior.]

J. tenuis, Willd. Bog-Rush.

Common, or abundant, throughout the state.

J. tenuis, Willd., var **congestus,** Engelm. Bog-Rush.

Blue Earth county, *Leiberg*, determined by *Watson.* Southwest. [Branches contracted into a head, and flowers darker-colored. *Engelmann, Trans. Acad. Sci., Saint Louis,* vol. ii.]

J. Vaseyi, Engelm. Vasey's Bog-Rush.

Steele county, *Upham* ; lake Superior and Manitoba, *Macoun* ; probably occurring throughout Minnesota.

J. pelocarpus, E. Meyer. Bog-Rush.

Lapham. St. Croix river, *Parry* ; lake Pepin, *Miss Manning.*

J. alpinus, Villars, var. **insignis,** Fries. Bog-Rush.

North shore of lake Superior, *Juni* ; lake of the Woods, *Dawson, Macoun.* North.

J. acuminatus, Michx., var. **legitimus,** Engelm. Bog-Rush.

Lapham. [North of lake Superior, *Agassiz* ; Manitoba, *Macoun* ; Devil's lake, Dakota, *Geyer.*] Throughout the state.

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*JUNCUS BALTICUS, Dethard, var. MONTANUS, Engelmann. Sepals nearly of the same length, the minor ones sometimes more obtuse ; anthers four times longer than the filament ; capsule ovate-pyramidal, angled, beaked ; seeds smaller, narrower and longer pointed than in the eastern form. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

J. nodosus, L. Bog-Rush.

Common throughout the state.

J. nodosus, L., var. **megacephalus**, Torr. Bog-Rush.

Common in Martin county, and in Emmet county, Iowa, *Cratty*; Manitoba, *Macoun*; probably throughout the state.

J. Canadensis, J. Gay, var. **longicaudatus**, Engelm. Bog-Rush.

Minneapolis. *Simmons*; Blue Earth county, *Leiberg*. Through the south part of the state.

J. Canadensis, J. Gay, var. **coarctatus**, Engelm. Bog-Rush.

North of lake Superior, *Juni*. [Manitoba, *Macoun*.] North.

PONTEDERIACEÆ. PICKEREL-WEED FAMILY.

PONTEDERIA, L. PICKEREL-WEED.

P. cordata, L. Pickerel-Weed.

Lake Pepin, *Miss Manning*; White Bear lake, Ramsey county, *Simmons*, *Kelley*; lake Minnetonka, also in Douglas county, *Mrs. Terry*; pond in section 23, Burns, Anoka county, *Roberts*; Stearns county, *Campbell*. Infrequent.

SCHOLLERA, Schreber. WATER STAR-GRASS.

S. graminifolia, Willd. Water Star-grass.

White Bear lake, Ramsey county, *Simmons*; lake Minnetonka, *Roberts*, *Miss Butler*; Blue Earth county, *Leiberg*. South.

COMMELYNACEÆ. SPIDERWORT FAMILY.

TRADESCANTIA, L. SPIDERWORT.

T. Virginica, L. Common Spiderwort.

Common, often abundant, through the south half of the state; extending northeast to the upper Mississippi river, and north to lake Winnipeg, *Watson*. Southwestward the flowers are often seen varying from the ordinary blue to purple and pink.

XYRIDACEÆ. YELLOW-EYED-GRASS FAMILY.

XYRIS, L. YELLOW-EYED GRASS.

X. flexuosa, Muhl. Yellow-eyed Grass.

Sandy lake, about three miles north of East Minneapolis, *Roberts*; also collected near Minneapolis by *Mr. Kassube*; White Bear, Ramsey county, *Miss Field*. Rare.

ERIOCAULONACEÆ. PIPEWORT FAMILY.

ERIOCAULON, L. PIPEWORT.

E. septangulare, With. Pipewort.

Lake Agnes, Alexandria, Douglas county, *Mrs. Terry*. Rare.

CYPERACEÆ. SEDGE FAMILY.

CYPERUS, L. GALINGALE.

C. diandrus, Torr., var. **castaneus**, Torr. (C. rivularis, Kunth.) Galingale.

Common through the south half of the state; extending north at least to the upper Mississippi river, *Garrison*.

C. erythrorrhizos, Muhl. Galingale.

Lapham. [In Michigan, Wisconsin and Nebraska.] Infrequent. South.

C. aristatus, Rottb. (C. inflexus, Muhl.) Galingale.

St. Croix river, *Parry;* Minneapolis, *Kassube, Simmons;* Blue Earth county, *Leiberg*. [Manitoba, *Macoun*, (lake Winnipeg) *Watson*; Emmet county, Iowa (rare), *Cratty*.] Throughout the state.

C. esculentus, L. (C. phymatodes, Muhl.) Galingale. Nut-Grass.

Lapham. Blue Earth county, *Leiberg;* Cannon River Falls, *Blake, Sandberg;* Minneapolis, *Simmons*. South.

C. strigosus, L. Galingale.

Common throughout the state, excepting perhaps northeastward. (Specimens apparently referable to this species, collected by *Mr. Simmons* near lake Calhoun, in Minneapolis, have only 8- to 12-flowered spikes, scarcely a half inch long, arranged in densely crowded spicate clusters, the lower portions of which are sometimes compound.)

C. Michauxianus, Schultes. Galignale.

Lapham. Blue Earth county, *Leiberg*. Probably frequent, or common, through the south part of the state.

C. Schweinitzii, Torr. Galingale.

Throughout the south half of the state and in the Red river valley. Sandy ridges, St. Croix river, *Parry;* Minneapolis (common), *Kassube, Upham;* Blue Earth county, *Leiberg*. [Emmet county, Iowa (very rare) *Cratty;* Devil's lake, Dakota, *Geyer*.]

C. filiculmis, Vahl. Galingale.

Common, or frequent, throughout the state, excepting perhaps northeastward. Upper Mississippi river, *Houghton;* Minnesota river, *Parry;* Minneapolis, *Kassube, Simmons, Upham;* Blue Earth county, *Leiberg*. [Manitoba, *Macoun*.]

DULICHIUM, Richard. DULICHIUM.

D. spathaceum, Pers. Dulichium.

Common, or frequent, throughout the state.

HEMICARPHA, Nees. HEMICARPHA.

H. subsquarrosa, Nees. Hemicarpha.

Lapham. Blue Earth county, *Leiberg;* Minneapolis, plentiful beside railroad near the University, *Arthur*, and near lake Calhoun, *Simmons;* probably frequent through the south half of the state.

ELEOCHARIS, R. Br. SPIKE-RUSH.

E. obtusa, Schultes. Spike-Rush.

Common through the south half of the state and in the Red river valley.

E. palustris, R. Br. Spike-Rush.

Common throughout the state.

E. palustris, R. Br., var. **glaucescens,** Gray. Spike-Rush.
Minneapolis, *Kassube.*

E. compressa, Sullivant. Spike-Rush.
Blue Earth county, *Leiberg.* [Emmet county, Iowa (rare), *Cratty.*] South.

E. intermedia, Schultes. Spike-Rush.
Lapham. Blue Earth county, *Leiberg.* Probably throughout the state.

E. tenuis, Schultes. Spike-rush.
Lapham. Blue Earth county (frequent in peat-bogs), *Leiberg.* [Devil's lake, Dakota, *Geyer.*]

E. acicularis, R. Br. Spike-Rush.
Common throughout the state.

E. Wolfii,* Gray. Wolf's Spike-Rush.
Collected by *Mr. R. I. Cratty* on wet prairies in Emmet county, Iowa, adjoining the south line of Martin and Jackson counties in Minnesota, where it may also be confidently looked for; determined by *Mr. William Boott.*

E. pauciflora, Watson. (Scirpus pauciflorus, Lightfoot.) Spike-Rush.
Lake Superior and lake of the Woods, *Macoun.* North.

SCIRPUS, L. BULRUSH or CLUB-RUSH.

S. cæspitosus, L. Bulrush or Club-Rush.
North and northwest of lake Superior, *Macoun;* doubtless in northern Minnesota.

S. pungens, Vahl. Bulrush.
Common throughout the state, excepting perhaps northeastward.

S. Torreyi, Olney. Torrey's Bulrush.
Lapham. Infrequent.

S. lacustris, L. (S. validus, Vahl.) Great Bulrush. "Black Rush." ["Tule" in California (S. lacustris, L., var. occidentalis, Watson).]
Abundant throughout the state. "In common use among the Indians for making mats." *Parry.*

S. debilis, Pursh. Bulrush.
Lapham. [Also in the Wisconsin catalogue, probably on *Dr. Lapham's* authority; and in Nebraska, *Aughey.*]

[S. maritimus, L., was collected by *Geyer* at Devil's lake and on the Sheyenne and James rivers, in Dakota. It will probably be found in the Red river valley in Minnesota.]

S. fluviatilis, Gray. River Club-Rush.
Through the south half of the state, and in the Red river valley. Minneapolis, *Roberts;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty;* Pembina, *Chickering.*

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*ELEOCHARIS WOLFII, Gray. Rhizomes very small, creeping, perennial, forming small scattered tufts; culm a foot high, slender, pale-glaucescent, striate, two-edged, one side flat, the other convex; sheath obliquely truncate, hyaline above: spike ovate-oblong, acute; scales oblong-ovate, obtuse, scarious, pale purple; style 3-parted; achenium pyriform, shining, having about 9 nearly equidistant obtuse ribs, with transverse wrinkles between; tubercle small, depressed, truncate, more or less apiculate; bristles of the perigynium [always?] none.—[First known from Illinois.] The spike, as to form and imbrication of the scales, is much as in E. tenuis and E. acicularis, etc.; but the achenium, with its several longitudinal ribs and delicate transverse lineation, is upon the plan of E. acicularis. This renders the species a very peculiar and distinct one. *Gray, Proc. Amer. Acad.*, vol. x, p. 77, as translated by *Arthur*, *Contributions to the Flora of Iowa, No. VI.*

S. sylvaticus, L., var. **digynus,** Boeck, (S. microcarpus, Presl.) Bulrush.

Lapham. Pine county, etc., *Upham.*

S. atrovirens, Muhl. Bulrush.

Common throughout the state. (*Mr. Leiberg* reports in Blue Earth county, besides the type, a variety with the heads less densely clustered than usual, forming a compound panicle.)

S. polyphyllus, Vahl. Bulrush.

Isanti county, *Upham.* South.

S. lineatus, Michx. Bulrush.

Blue Earth county, *Leiberg;* Minneapolis, *Simmons.* South.

S. Eriophorum, Michx. Wool-Grass.

Frequent throughout the state, excepting perhaps southwestward. Blue Earth county, *Leiberg;* Minneapolis, *Simmons, Kassube;* Todd county, etc., *Upham;* lake of the Woods, *Dawson, Macoun.* [North of lake Superior, *Agassiz.*]

ERIOPHORUM, L. COTTON-GRASS.

E. alpinum, L. Alpine Cotton-Grass.

North of lake Superior, *Juni.*

E. vaginatum, L. Sheathed Cotton-Grass.

Throughout the state, excepting far southward. Blue Earth county, *Leiberg;* Minneapolis, *Kassube;* Anoka county, *Juni;* Chisago county (frequent), *Upham.* [Manitoba, *Macoun.*]

[E. Virginicum, L., doubtless will be found in this state, but has not yet been reported. It occurs in Wisconsin, Nebraska and Manitoba.]

E. polystachyum, L. Many-stemmed Cotton-Grass.

Common, or frequent, through the south half of the state, and perhaps farther north. Anoka county, *Juni;* Minneapolis, *Herrick, Simmons;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty.* It has been noted in its var. ANGUSTIFOLIUM, Gray, at Minneapolis, *Kassube,* and in Steele county, *Upham.*

E. polystachyum, L., var. **latifolium,** Gray. Cotton-Grass.

Minneapolis, *Upham;* and probably extending, with the var. angustifolium, through the south half of the state.

E. gracile, Koch, var. **paucinervium,** Engelm. Graceful Cotton-Grass.

Throughout the state. Chisago county (frequent), and Sherburne county, *Upham;* Minneapolis, *Simmons;* Blue Earth county, *Leiberg.* [Manitoba, *Macoun;* Emmet county, Iowa (rare), *Cratty.*]

FIMBRISTYLIS, Vahl. FIMBRISTYLIS.

F. capillaris, Gray. Fimbristylis.

Lapham. Infrequent. South.

RHYNCHOSPORA, Vahl. BEAK-RUSH.

R. alba, Vahl. Beak-Rush

Lapham. Infrequent. South.

R. capillacea, Torr. Beak-Rush.

Blue Earth county, *Leiberg.* Infrequent. South.

[Cladium mariscoides, Torr., should be looked for in southern Minnesota.]

SCLERIA, L. NUT-RUSH.

S. triglomerata, Michx. Nut-Rush.
Lapham. Infrequent. South.

S. verticillata, Muhl. Nut-Rush.
Blue Earth county, *Leiberg.* Rare. South.

CAREX, L. SEDGE.

C. scirpoidea, Michx. Sedge.
Port Arthur, and "northwest angle" of the lake of the Woods, *Macoun.* North.

C. polytrichoides, Muhl. Sedge.
Little Marais, lake Superior, *Juni.* Probably common throughout the state.

C. Backii, Boott. Back's Sedge.
Minneapolis, *Juni.* North.

C. siccata, Dew. Sedge.
Throughout the state, but infrequent. *Lapham.* Minneapolis, *Kassube;* Emmet county, Iowa (very rare), *Cratty.*

C. disticha, Huds. Sedge.
Throughout the state. Minneapolis, *Juni, Kassube;* Emmet county, Iowa (common) *Cratty.*

C. teretiuscula, Good. Sedge.
Throughout the state. Minneapolis, *Juni;* Blue Earth county, *Leiberg.*

C. teretiuscula, Good., var. **ramosa,** Boott.* Sedge.
Emmet county, Iowa (frequent), *Cratty;* doubtless also in Minnesota.

C. vulpinoidea, Michx. Sedge.
Common throughout the state. Minneapolis, *Juni;* Blue Earth county, *Leiberg·* common in Martin county, and in Emmet county, Iowa, *Cratty.*

C. crus-corvi, Shuttleworth. Sedge.
Blue Earth county, *Leiberg.* South.

C. stipata, Muhl. Sedge.
Common throughout the state. Moose Lake, Carlton county, *Juni;* Blue Earth county, *Leiberg.*

C. conjuncta, Boott. Sedge.
Minneapolis, *Juni, Kassube.* Southeast.

C. Douglasii, Boott.† Douglas's Sedge.
Red river (open prairie); "this is the first Carex to appear in flower, and occurs very abundantly all over the prairie of the Red river," *Dawson, Macoun.* West.

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*CAREX TERETIUSCULA, Good., var. RAMOSA, Boott. (C. prairiea, Dew.) Spike below branched; spikelets ovate, sessile, 5 to 7 on a branch; perigynium ovate-lanceolate, convex both sides, scabrous on the margin, slightly bifid, smaller than the ovate-lanceolate glume; stem 2 to 3 feet high, leafy towards the base. *Wood's Class-Book.*

†CAREX DOUGLASII, Boott. Spike diœcious, with about twelve, sometimes more, ovate spikelets, the upper closely aggregated, the lower occasionally remote and compound; bracts sometimes setaceous, broad at base, sometimes scale-like and mucronate; style exserted; stigmas 2, very long; perigynium elliptic-lanceolate or ovate, tapering to a long serrated bifid beak, shorter than the lanceolate acute scale; achenium orbicular. Root creeping; culm 6 to 12 inches high. *Olney* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

C. marcida, Boott.* Sedge.

Red river (open prairie swamp), *Dawson, Macoun.* West.

C. cephaloidea, Boott. Sedge.

Throughout the state, excepting perhaps northeastward. Frequent in Martin county, and in Emmet county, Iowa, *Cratty;* swamps, "northwest angle" of lake of the Woods, *Macoun.*

C. cephalophora, Muhl. Sedge.

Common, or frequent, through the south part of the state. Blue Earth county, *Leiberg.*

C. Muhlenbergii, Schk. Sedge.

Lapham. Chaska, Carver county, *Juni.* Rare. South.

C. rosea, Schk. Sedge.

Common, or frequent, throughout the state. Red river (swamp), *Dawson, Macoun;* Minneapolis, *Juni, Kassube;* Blue Earth county, *Leiberg;* Hesper, Iowa (frequent), *Mrs. Carter;* Martin county, and Emmet county, Iowa (common), *Cratty.*

C. chordorhiza, Ehrh. Sedge.

Throughout the state, but infrequent. [North of lake Superior (at Fort William), *Macoun;* Emmet county, Iowa, *Arthur.*]

C. tenella, Schk. Sedge.

Throughout the state, excepting far southward. Minneapolis, *Juni, Kassube.*

C. trisperma, Dew. Sedge.

Range like the last. Put in bay, lake Superior, *Juni.*

C. tenuiflora, Wahl. Sedge.

Range like the two preceding. Minneapolis, *Juni, Herrick.*

C. canescens, L. Sedge.

Throughout the state: common northward, less frequent southward. Blue Earth county, *Leiberg.*

C. canescens, L., var. **alpicola**, Wahl. (var. vitilis, Carey.) Sedge.

Agate bay, lake Superior, *Juni.* North.

C. arcta, Boott.† Sedge.

Lake Superior, Rainy lake, and lake of the Woods, *Richardson, Boott.* North.

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*Carex marcida, Boott. Spike oblong, pale, composed of numerous small ovate aggregated androgynous spikelets, staminate at top, the lower spikelets compound; stigmas 2; perigynium tawny, suborbicular, or ovate tapering to a bifid beak, plano-convex, nerved, winged, the upper margins serrated, short-stipitate, nearly equal to the acute ovate scale, which is of a pale straw-color, with a white membranous margin; achenium tawny, lenticular, contracted at base. Culm 1 to 2 feet high, rigid; leaves broad, linear, erect. *Olney* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

†Carex arcta, Boott. Spike oblong, capitate, pale, of 8 to 14 spikelets, which are oblong and obtuse, androgynous, at the base sparingly staminate, many-flowered, closely crowded, the lower bracteate; bracts bristle-shaped, dilated at the base, longer than the spikelets; stigmas 2; perigynia ovate, acuminate-beaked, with the minute orifice emarginate and deeply cleft on the outer side, serrate above on the sharp margins, on the outer side slightly nerved, on the inner more sparingly or obsoletely nerved, spreading, pale-green, at length becoming rusty above, membranaceous, at the base thickly spongy; longer than (and as broad as) the scale, which is ovate, acute and mucronulate, whitish or rusty-colored, with a greenish margin and a green mid-nerve. . . . Culm somewhat less than a foot high, sharply triangular, rather stout, upwardly roughish, leaved at the base. Leaves 1 to 1½ lines wide, flat, with a prolonged-tapering tip, longer (often much) than the culm. Bracts at their base broadly dilated, bristle-

C. Deweyana, Schw. Sedge.

Throughout the state. Agate bay, lake Superior, *Juni;* Spirit Lake, Iowa, *Arthur.*

C. echinata, Murr. (C. stellulata, Good.) Sedge.

Throughout the state. North of lake Superior, *Agassiz;* Manitoba, *Macoun;* Emmet county, Iowa, *Cratty, Arthur.*

C. echinata, Murr., var. **microcarpa,** Boeck. (C. stellulata, Good., var. scirpoides, Carey.) Sedge.

Minneapolis, *Juni, Kassube;* Emmet county, Iowa (frequent), *Cratty.*

C. arida, Schw. & Torr. Sedge.

Throughout the state, but infrequent. [Near Winnipeg, Manitoba, *Macoun;* upper Missouri river, *Geyer.*]

C. scoparia, Schk. Sedge.

Common throughout the state. Minneapolis, *Juni;* Blue Earth county, *Leiberg.*

C. lagopodioides, Schk. Sedge.

Common, or frequent, throughout the state. *Lapham.* Savannah river, *Houghton;* Agate bay, lake Superior, *Juni.*

C. cristata, Schw. Sedge.

Throughout the state, excepting perhaps northeastward. Blue Earth county, *Leiberg;* Emmet county, Iowa (rare), *Cratty.*

C. adusta, Boott. Sedge.

Throughout the state, but rare. Red river valley, at Pembina, *Dawson;* Minneapolis, *Kassube.*

C. straminea, Schk. (Including vars. typica, tenera, aperta and festucacea, Boott.) Sedge.

Throughout the state. St. Louis river, *Houghton;* Pembina, *Dawson;* Minneapolis, *Kassube;* Blue Earth County, *Leiberg.*

C. straminea, Schk., var. **Crawei,** Boott. (vars. hyalina and Meadii, Boott.) Sedge.

Common in Emmet county, Iowa (on the southern boundary of Minnesota), *Cratty.*

C. vulgaris, Fries. Sedge.

Throughout the state, excepting perhaps far southward. Minneapolis, *Juni;* Blue Earth county, *Leiberg.*

C. aquatilis, Wahl. Sedge.

Range like the last. *Lapham.* Minneapolis, also New Ulm, *Juni.*

C. stricta, Lam. (See *Botanical Gazette* for Sept., 1884.) Sedge.

Common throughout the state. Agate bay, lake Superior, *Juni;* Red river, *Dawson, Macoun;* Minneapolis, *Kassube;* Blue Earth county, *Leiberg;* plentiful in Emmet county, Iowa, *Cratty.*

C. lenticularis, Michx. Sedge.

Agate bay, lake Superior, *Juni.* North.

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shaped, the lower 5 or 6 elongated, the lowest hardly equaling the spike. Spike 10 to 16 lines long, 3 to 6 lines broad. Spikelets 5 lines long, 2 to 2½ lines broad, dense flowered, at the base sparingly staminate but never narrowed below, all crowded. Scales similar. Perigynium 1.3 to 1.4 lines long, 0.6 line broad. Achenium 0.7 line long, 0.5 line broad, suborbicular, prolonged at the base, plano-convex, pale ; the base of the style enlarged.——It differs from C. canescens and C. vitilis in its more numerous spikelets, in their being capitate and the lower ones bracted, and in its longer leaves, In general appearance it more nearly resembles C. elongata, yet in the form and nervation of the perigynium it is far different. *Boott's Illustrations of Carex.*

C. crinita, Lam. Sedge.

Throughout the state, excepting perhaps far southward. North of lake Superior, *Juni.*

C. crinita, Lam., var. **gynandra**, Schw. & Torr. (C. gynandra, Schw.) Sedge.

Agate bay, lake Superior, *Juni.* Rare.

C. limosa, L. Sedge.

Throughout the state, but infrequent. [North of lake Superior (at Fort William), *Macoun;* Emmet county, Iowa, *Cratty, Arthur.*]

C. Magellanica, Lam. (C. irrigua, Smith.) Sedge.

Throughout the state, excepting far southward, but rare. Put in bay, lake Superior, *Juni.*

C. Buxbaumii, Wahl. Sedge.

Throughout the state. Blue Earth county, *Leiberg;* Emmet county, Iowa (frequent), *Cratty*.

C. atrata, L. Sedge.

Kakabeka falls, north of lake Superior, *Macoun;* probably also in northern Minnesota.

C. alpina, Swartz. Sedge.

Temperance river, lake Superior, *Juni.* North.

C. aurea, Nutt. Sedge.

Throughout the state, excepting perhaps far southward. Lake of the Woods (thicket), *Dawson, Macoun;* Minneapolis, *Juni, Kassube.*

[C. aurea, Nutt., var. androgyna, Olney,* collected by *Macoun* at Thunder bay, lake Superior, should be looked for in northern Minnesota.]

C. livida, Willd. Sedge.

Greenwood river, lake Superior, *Juni.* Rare. North.

C. vaginata, Tausch. Sedge.

Certainly in swamps in northern Minnesota, *Macoun.* North.

C. Meadii, Dew. Mead's Sedge.

Minneapolis, *Kassube.* [Manitoba, *Macoun;* Iowa, *Arthur.*]

C. Meadii, Dew., var. **Bebbii**, Arthur.† Sedge.

Emmet county, Iowa, *Cratty, Arthur;* doubtless also in Minnesota.

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*CAREX AUREA, Nutt., var. ANDROGYNA, Olney. Culms short, more rigid; leaves erect, broader; upper spikes more closely aggregated and denser flowered, the upper spike generally androgynous, having more or less fertile flowers at the top. *Olney* in *Bot. Rep. of King's Expl. of the Fortieth Parallel.*

†CAREX MEADII, Dew., var. BEBBII (Olney). This was published in Olney's *Carices Bor.-Amer.*, Fasc. 1, No. 22, without comments, as a variety of C. panicea, L., and has never, I believe, been described. The following description will enable collectors to identify the plant:—Sterile spike with stalk two to four times its length; fertile spikes usually 2, erect, remote, slender-peduncled, rather loosely flowered; sheaths of the foliaceous bracts long and slightly inflated; perigynia and scales as in C. Meadii, except paler, and the former less distinctly nerved; culms slender, somewhat roughish.—Resembles C. tetanica, for which it is sometimes mistaken, in habit and in the loosely flowered fertile spikes, only with longer peduncles, but C. Meadii in the perigynia and scales; it may be merely an attenuated form of the latter. Moist prairies, Illinois, Wisconsin, and northwestwardly. *Arthur* in *Contributions to the Flora of Iowa, No. VI.*

C. **Crawei,** Dew. Sedge.

Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty*, determined by *Mr. William Boott*. [Manitoba, *Macoun*.] Rare.

C. **granularis,** Muhl. Sedge.

Common throughout the state. Minneapolis, *Juni, Kassube;* Blue Earth county, *Leiberg.*

C. **Torreyi,** Tuckerman. Sedge.

Minneapolis, *Juni, Kassube;* Red river valley, *Macoun*. North.

C. **grisea,** Wahl. Sedge.

Blue Earth county, *Leiberg;* Martin county, *Cratty.*

C. **Davisii,** Schw. & Torr. Sedge.

Through the south part of the state. Minneapolis, *Simmons*.

C. **gracillima,** Schw. Sedge.

Throughout the state, excepting perhaps far southward. Minneapolis, *Juni, Kassube;* Blue Earth county, *Leiberg*.

C. **digitalis,** Willd. Sedge.

Minneapolis, *Juni;* north of lake Superior, *Agassiz*. Infrequent.

C. **laxiflora,** Lam. Sedge.

Common, or frequent, throughout the state. Blue Earth county, *Leiberg.*

C. **laxiflora,** Lam., var. **blanda**, Boott. Sedge.

Jordan, Scott county, *Juni;* Emmet county, Iowa, *Cratty*. Doubtless other varieties of this species also occur here.

C. **eburnea**, Boott. Sedge.

Throughout the state, excepting perhaps southwestward. Blue Earth county, *Leiberg;* Emmet county, Iowa (rare), *Cratty.*

C. **pedunculata,** Muhl. Sedge.

Throughout the state. Rainy lake, *Richardson, Boott;* Blue Earth county, *Leiberg.*

C. **Emmonsii,** Dew. Emmons' Sedge.

Blue Earth county, *Leiberg*. [Manitoba, *Macoun*.]

C. **Pennsylvanica,** Lam. Sedge.

Common throughout the state, excepting perhaps northeastward. Minneapolis, *Juni, Kassube;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty.*

C. **varia,** Muhl. Sedge.

Lapham. Infrequent.

C. **Richardsonii,** R. Br. Richardson's Sedge.

Throughout the state. Minneapolis, *Juni*, (frequent) *Kassube;* Blue Earth county, *Leiberg.*

C. **pubescens,** Muhl. Sedge.

Through the south part of the state. Minneapolis, *Juni, Kassube;* Blue Earth county, *Leiberg.*

C. **miliacea,** Muhl. Sedge.

Range like the last. Minneapolis, *Juni, Kassube*.

C. **arctata,** Boott. Sedge.

Agate bay, lake Superior, *Juni.* Infrequent.

C. **capillaris,** L. Sedge.

Port Arthur, lake Superior, *Macoun;* Saskatchewan river, *Bourgeau;* probably also in northern Minnesota.

C. flexilis, Rudge. Sedge.

Knife river, lake Superior, *Juni*. Rare. North.

C. Œderi, Ehrh. Sedge.

Throughout the state, excepting perhaps far southward. *Lapham*. Leech lake, *Houghton;* Rainy river and lake, *Richardson, Boott.*

C. filiformis, L. Sedge.

Throughout the state. Put in bay, lake Superior, *Juni;* Emmet county, Iowa (frequent), *Cratty*.

C. filiformis, L., var. **latifolia**, Boeck. (C. lanuginosa, Michx.) Sedge.

Throughout the state. North shore of lake Superior (frequent), and Minneapolis, *Juni;* Red river valley near Saint Vincent, *Dawson, Macoun;* Emmet county, Iowa (plentiful), *Cratty*.

C. Houghtonii, Torr. Houghton's Sedge.

Itasca lake (Lac la Biche), *Houghton;* Blue Earth county, *Leiberg*. [Manitoba, *Macoun;* Council Bluffs, Iowa, *Geyer*.]

C. riparia, Curtis. Sedge.

Common, or frequent, throughout the state. North of lake Superior (common), *Juni;* lake of the Woods (sandy swamp), *Dawson, Macoun;* Blue Earth county, *Leiberg*.

C. aristata, R. Br. Sedge.

Throughout the state, but infrequent. Pembina, *Chickering;* New Ulm, *Juni;* Blue Earth county, *Leiberg*.

C. Pseudo-Cyperus, L., var. **comosa**, W. Boott. (C. comosa, Boott.) Sedge.

Common, or frequent, through the south part of the state. Blue Earth county, *Leiberg*; Emmet and Dickinson counties, Iowa (frequent), *Cratty, Arthur*.

C. Pseudo-Cyperus, L. Sedge.

Throughout the state. Lake of the Woods (marsh), *Dawson, Macoun*; Chaska, Carver county, *Juni;* Spirit Lake, Iowa, *Arthur*.

C. hystricina, Willd. Sedge.

Common throughout the state, excepting perhaps far northwestward. *Lapham*. Minneapolis, *Juni, Kassube;* north of lake Superior, *Agassiz*.

C. tentaculata, Muhl. Sedge.

Range like the last, but less frequent. *Lapham*. Minneapolis, *Simmons;* north of lake Superior, *Agassiz*.

C. intumescens, Rudge. Sedge.

Common throughout the state. Lake of the Woods and Rainy lake, *Richardson, Boott;* north of lake Superior (common), also New Ulm, *Juni*.

C. lupulina, Muhl. Sedge.

Blue Earth county, *Leiberg;* Minneapolis, *Simmons*. [Manitoba, *Macoun*.]

C. squarrosa, L. Sedge.

Wabasha, *Gibson*, determined by *Arthur*. South.

C. retrorsa, Schw. Sedge.

Throughout the state. Lake of the Woods, *Richardson, Boott;* Moose Lake, Carlton county, *Juni;* Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty*.

C. utriculata, Boott. Sedge.

Throughout the state, excepting far southward. Red river prairie, *Dawson, Macoun*.

C. monile, Tuckerman. Sedge.

North of lake Superior, *Juni;* Emmet county, Iowa (frequent), *Cratty*.

C. oligosperma, Michx. Sedge.

Agate bay, lake Superior *Juni*. Infrequent. North.

C. saxatilis, L.. var. **miliaris,** Bailey. (C. miliaris, Michx. C. rotundata, Wahl.?, in *Manual.*) Sedge.

Collected in Minnesota by *Dr. J. Leidy;* determined by *S. T. Olney. Bot. Rep. of King's Expl. of the Fortieth Parallel.*

C. longirostris, Torr. Sedge.

Throughout the state. Minneapolis, *Juni, Kassube;* Mankato (common), *Leiberg;* also common in Martin county, and in Emmet county, Iowa, *Cratty*.

[A considerable number of species of Carex not here recorded will doubtless be added by future observers in this state, who should look for all such as approach, or are especially northern, in their geographic range, given in Gray's *Manual.*]

GRAMINEÆ. GRASS FAMILY.

LEERSIA, Swartz. WHITE GRASS. FALSE RICE.

L. Virginica, Willd. White Grass.

Ramsey and Goodhue counties, *Oestlund;* Minneapolis, *Simmons;* Blue Earth county, *Leiberg;* Emmet county, Iowa (rare), *Cratty*. South.

L. oryzoides, Swartz. Rice Cut-grass.

Common in sloughs through the south half of the state and in the Red river valley, *Juni, Upham;* Ramsey and Goodhue counties, *Oestlund;* Blue Earth county. *Leiberg*.

L. lenticularis, Michx. Fly-catch Grass.

Lapham. South.

ZIZANIA, L. WATER or INDIAN RICE.

Z. aquatica, L. Wild Rice. Indian Rice. Water Oats. Folle Avoine (of the French voyageurs).

Common, or frequent, in favorable situations, throughout the state; sometimes attaining, in Brown county, a hight of 13 feet, with leaves 4 feet long. *Juni*.

"Wild rice; *Pshu* of the Sioux; *Manomin* of the Chippewas. This aquatic grass, not uncommon in the Northern United States, acquires in the Northwest an economical importance second to no other spontaneous production. It is the only instance in this region of a native grain, occurring in sufficient quantity to supply the wants of ordinary consumption. It is particularly abundant on the lake-like expansions of rivers, towards their sources, which give such a marked feature to the distribution of these northern streams, and is so grandly illustrated in their main type, the Mississippi. It seems to select, by preference, the lower terminations of these expansions, which generally debouch by a narrowed outlet and considerable fall, constituting rapids. It is in these situations best exposed to the proper degree of inundation, and finds a suitable bed of the slimy sand, in which it grows most readily. It is rarely met with on inland lakes which have no outlet. As an article of food it is highly palatable and nutritious, being generally preferred to the commercial rice. The grain is long, slender, of a brown color. In boiling, it puffs out to a pultaceous mass, and increases its bulk several times. It flowers in August, and is ready for gathering in September, which is conveniently done in canoes, the standing stalks being bent over the sides, and the grain beaten in. Its productive fields, at this season, harbour a great number of wild fowls, which obliges those who wish to secure a full crop, to anticipate the gathering season, by tying up the standing grain into bundles, which gives at the same time a claim to the crop. When gathered it is subjected to a process of parching and thrashing, which, with the imperfect means at the command of the Indians, is the most tedious part of the business." *Parry*.

ALOPECURUS, L. FOXTAIL GRASS.

A. geniculatus, L., var. **aristulatus**, Munro. (A. aristulatus, Michx.) Wild Foxtail.

Common, or frequent, throughout the state.

PHLEUM, L. CAT'S-TAIL GRASS.

P. pratense, L. *Timothy. Herd's-Grass* (of New England).

Commonly cultivated, often spontaneous, throughout the state.

SPOROBOLUS, R. Br. (Including VILFA, Beauv.) DROP-SEED GRASS. RUSH-GRASS.

S. asper, Kunth. (Vilfa aspera, Beauv.) Rush-Grass.

Lapham. New Ulm, *Juni*. South.

S. vaginæflorus, Torr. (V. vaginæflora, Torr.) Rush-Grass.

Lapham. Minneapolis (sandy bottomland of the Mississippi river), *Oestlund;* Emmet county, Iowa (frequent), *Cratty*. South.

S. cuspidatus, Torr. (V. cuspidata, Torr.) Rush-Grass.

Lapham. Hennepin and Goodhue counties, *Oestlund;* Emmet county, Iowa (rare), *Cratty*. [Devil's lake, and southern Dakota, *Geyer;* Manitoba, *Macoun*.]

S. depauperatus, Torr.* (V. depauperata, Torr.) Rush-Grass.

Red river valley, at Pembina, *Havard*. West.

S. junceus, Kunth. Drop-seed Grass.

Lapham. New Ulm, *Juni*. Rare. South.

S. heterolepis, Gray. Drop-seed Grass.

Throughout the state, excepting perhaps northeastward. Ramsey county, *Oestlund;* Blue Earth county, *Leiberg;* common in Emmet county, Iowa, *Cratty*. [Eastern Nebraska (abundant), *Aughey;* Manitoba, *Macoun*.]

S. cryptandrus, Gray. Drop-seed Grass.

Through the south part of the state. Ramsey county, *Oestlund*; Minneapolis, *Simmons, Upham, Dr. Vasey;* Emmet county, Iowa (rare), *Cratty;* Spirit lake and Little Sioux river, *Geyer*.

AGROSTIS, L. BENT-GRASS.

A. perennans, Tuckerman. Thin-Grass.

Throughout the state, excepting perhaps northeastward. *Lapham*. Minneapolis, *Upham;* Pembina, *Havard*.

A. scabra, Willd. Hair-Grass.

Common, or frequent, throughout the state.

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*SPOROBOLUS DEPAUPERATUS, Torr. Root perennial, creeping; culms ascending, appressed-branched, slender, often geniculate, glabrous, striate, rather rigid, ½ to 2 feet long; leaves 1 to 3 inches long, narrow and usually convolute, spreading or recurved; panicle very slender and contracted, 1 to 3 inches long; compound or often nearly simple; spikelets small; glumes unequal, ovate, obtuse or acutish, membranous, two-thirds the length of the acute lower palet, which is more less obscurely 3-nerved.——Resembling V. cuspidata, and scarcely differing except in the shorter obtuse glumes of the rather smaller flowers. Lower palet a little more than 1 line long, glabrous or slightly scabrous on the midnerve, the upper one obtuse or erose at the summit. *Watson's Rep.* in *King's Expl. of the Fortieth Parallel.*

A. canina, L. Brown Bent-Grass.

Pipestone county, *Leiberg.* Rare.

A. vulgaris, With. Red-top. Herd's-Grass (of Pennsylvania, &c.)

Probably native northward; also much cultivated, and thence often spontaneous, throughout the state. (According to *Dr. George Thurber*, in the *Botany of California*, this should be called a variety of A. alba, L.)

A. vulgaris, With., var. **alba,** Vasey. (A. alba, L.) Fiorin. White Bent-Grass.

Ramsey county, *Oestlund*: Red Wing, *Sandberg*; Blue Earth county, *Leiberg*; New Ulm, *Juni.* [Lake Superior, *Whitney.*]

CINNA, L. Wood Reed-Grass.

C. arundinacea, L. Wood Reed-Grass.

Throughout the state. *Lapham.* Upper Mississippi river, *Houghton*; Blue Earth county, *Leiberg.*

C. pendula, Trin. (C. arundinacea, L., var. pendula, Gray.) Wood Reed-Grass.

Lake Superior and northward, Gray's *Manual*; doubtless in northern Minnesota.

MUHLENBERGIA, Schreber. Drop-seed Grass.

M. sobolifera, Trin. Drop-seed Grass.

Lapham. South.

M. glomerata, Trin. Drop-seed Grass.

Common, or frequent, throughout the state; not confined to wet places, but often growing on dry and even sandy ground; abundant southwestward, frequently persisting as a plentiful weed in wheat-fields and other cultivated land, *Upham.*

M. glomerata, Trin., var. **ramosa,** Vasey, ined. Drop-seed Grass.

Minneapolis (bluff of Mississippi river near the University), *Upham;* probably the prevailing form of the species in this state. [Much branched from the base upward, the lateral branches slender, naked above, very leafy; outer glumes only slightly longer to one-third longer than the flower; flowering glume sparingly villous. Minnesota, Dakota and Utah. *Letter of Dr. Vasey*, Sept. 30, 1884.]

M. Mexicana, Trin. Drop-seed Grass.

Ramsey county, *Oestlund*; Blue Earth county, and southwestward (common), *Leiberg*; Pembina, *Havard.*

M. sylvatica, Torr. & Gray. Drop-seed Grass.

Lapham. North of lake Superior, *Agassiz.* Probably throughout the state.

M. Willdenovii, Trin. Drop-seed Grass.

Through the south part of the state. *Lapham.* Blue Earth county, *Leiberg.*

M. ambigua, Torr.* Drop-seed Grass.

Stony banks of Okaman lake (lake Elysian), Waseca county, *Geyer.*

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*Muhlenbergia ambigua, Torr. Panicle dense, spiciform; glumes rather unequal (the inferior one shorter), linear-lanceolate, very acute, 1- or 2-flowered, very hairy at the base; superior valve [palet] with a bristle at the tip equalling it in length, a little shorter than the glumes (exclusive of the awns); superior floret either perfect, and then resembling the inferior, or rudimentary and aristiform. . . . Culms cæspitose, about 1½ feet high, glabrous; leaves broadly linear; stipules very short, truncate

BRACHYELYTRUM, Beauv. BRACHYELYTRUM.

B. aristatum, Beauv. Brachyelytrum.

Lapham. Blue Earth county, *Leiberg.*

DEYEUXIA, Clarion. (Included in CALAMAGROSTIS, Gray's *Manual.*) REED BENT-GRASS.

D. Canadensis, Beauv. Blue-Joint.

Common throughout the state. The principal grass of the natural meadows bordering streams in the wooded region northward, supplying an abundance of excellent hay for the logging teams of the pineries.

D. stricta, Trin. Reed Bent-Grass.

Throughout the state. Collected in Minnesota by *Nicollet* (*Watson*): Ramsey and Hennepin counties, *Oestlund*; Minneapolis, *Simmons*; Blue Earth County, *Leiberg*; Emmet county, Iowa (common), *Cratty*; Pembina, *Havard.*

D. Lapponica, Kunth. (Calamagrostis Lapponica, Trin., in Addenda of Gray's *Manual.*) Reed Bent-Grass.

Isle Royale, lake Superior, *Prof. T. C. Porter*; doubtless also in northern Minnesota.

D. confinis, Nutt. Reed Bent-Grass.

Lapham. Common in Grant county and the Red River valley, *Upham.*

D. Nuttalliana, Steud. Reed Bent-Grass.

Lapham. Lake Winnibigoshish, *Houghton;* Minneapolis, *Kassube.*

AMMOPHILA, Host. (§§ 2 and 3, CALAMAGROSTIS, Gray's *Manual.*) REED BENT-GRASS.

A. longifolia, Benth. (C. longifolia, Hook.) Reed Bent-Grass.

Throughout the state. Ramsey county, *Oestlund*; Saint Paul, *Kelley;* Minneapolis, also northwestward (common on the beaches of lake Agassiz), *Upham*; Blue Earth county, *Leiberg.*

A. arundinacea, Host. (C. arenaria, Roth.) Sea Sand-Reed.

Common on southern beaches of lake Superior, *Whitney;* doubtless also on the shore of this lake in Minnesota.

ORYZOPSIS, Michx. MOUNTAIN RICE.

O. melanocarpa, Muhl. Mountain Rice.

Lapham. Ramsey county, *Oestlund;* Minneapolis, *Simmons*; Blue Earth county, *Leiberg.*

O. asperifolia, Michx. Mountain Rice.

Throughout the state, excepting perhaps far southward. *Lapham.* Stearns county, *Garrison;* Minneapolis, *Simmons.*

O. Canadensis, Torr. Mountain Rice.

Lapham. Infrequent. Range like the last.

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and lacerate; panicle 4 to 6 inches long, purplish; glumes tapering to a very acute cuspidate point, with a strong green midrib; perianth clothed at the base with whitish hairs, which are nearly half as long as the valves; valves nearly equal; awn a little tortuous, sometimes longer than the valve; superior floret often perfect, and maturing its fruit; when rudimentary, consisting of a mere awn, without any valve. A remarkable species, with the habit of M. glomerata and M. Mexicana. *Torrey* in *Nicollet's Report.*

STIPA, L. Feather-Grass. Weather-Grass.

S. Richardsonii, Link. Richardson's Feather-Grass.

North shore of lake Superior, and in Manitoba, *Macoun;* doubtless reaching into Minnesota. North.

S. spartea, Trin. Porcupine Grass.

Abundant southwestward, being the principal grass of the prairie in some districts, and extending undiminished into Dakota; common north to Clay county and east to New Ulm; frequent northeast to the sources of the Mississippi, *Houghton*, and to Sherburne and Anoka counties, and in the southeast part of the state, *Upham*. (See *American Naturalist*, vol. xviii, pp. 929-931.) The grain is prolonged below in a stout callus or base, needle-like in sharpness, and above in a long twisted awn; both of which are minutely barbed, so that, when inserted in the wool of sheep or in men's clothing, the seed works forward readily but not backward. Thus this very appropriately named grass is a serious annoyance at the time of maturity and falling of the seed, which is in July. Within a few weeks later, these seeds are found to have bored into the hard, dry, clayey soil of the prairie to a depth of two or three inches, having been pushed or impelled in some way by means of the awn. Perhaps this is effected by its lengthening, while braced against the herbage above, after it had been contracted by partially coiling up, these changes being produced by alternations of dryness and moisture, as in days of sunshine and dewy nights; or, as seems more probable, it may be that the wind, blowing upon the awn, first fastens the sharp-pointed grain in the ground, and afterward slowly drills it downward. This was first brought to the notice of the writer by *Mr. T. M. Young*, at the Sisseton Agency, in Dakota, where, late in August, scarcely any seeds of this grass remained on the surface; but they were found very plentifully thus buried in the ground, often only from a half inch to one inch apart. All had penetrated to nearly the same depth, which was about two and a half inches from the surface to the point of the seed, two thirds of this depth being occupied by the lower part of the awn.

ARISTIDA, L. Triple-awned Grass.

A. basiramea, Engelmann.* Triple-awned Grass.

Minneapolis (plentiful in the vicinity of the University, in the sward on dry sandy land with species of Bouteloua, Poa and Andropogon, from which it is noticeably distinguished by its darker purplish color), *Upham;* Saint Cloud (plentiful), *Campbell;* Pipestone City and Luverne, in southwestern Minnesota, and near Rock Rapids, Lyon county, in the northwest corner of Iowa, *Leiberg*.

It has also been collected in Nebraska by *Rev. J. H. Wibbe*, and in Kansas by *Mr. E. Hall;* and *Mr. F. L. Scribner* and *Prof. J. M. Coulter* report it from Iowa and Illinois. *Rev. J. Scott* writes that it occurs at Brandon, Manitoba. [Nebraska specimens show a much greater size (20 inches high) and a more branching habit, the culms becoming geniculate. *Vasey.*]

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*Aristida basiramea, Engelmann in a letter to W. Upham.——Annual: culms erect, 6 to 15 inches high, slender, much branched at the base (some of the branches very short but floriferous), and with short floriferous branches enclosed in the upper leaf-sheaths: leaves comparatively long (3 to 6 inches), narrowly linear, flat, becoming involute toward the apex, sparsely hairy on the margins below, the upper ones nearly equaling the panicle; sheaths striate, loose; ligule very short, truncate: panicle 1½ to 3 inches long, erect, rather lax, its base sheathed by the upper leaf; branches of the panicle short, mostly single, the lower in twos or threes; glumes linear, unequal, 1-nerved, lower one 4 lines, upper one 6 lines long including the short bristle-like point: flowering glume nearly terete, spotted with black, about 5 lines long including the short, acute and hairy callus; middle awn about 6 lines long, the lateral ones about 4 lines long, spirally twisted below (when mature). The sheathed flowers are somewhat smaller.

This species was discovered last season by Mr. Warren Upham, at Minneapolis, Minn. The late Dr. Engelmann suggested the name, in a letter, as indicative of its habit, and would have published it if he had lived. It is closely related to A. dicho-

A. purpurea, Nutt.* Triple-awned Grass.

Blue Earth county, and common westward to Pipestone county, *Leiberg*. South-west.

A. purpurascens, Poir. Triple-awned Grass.

Lapham. St. Croix county, Wisconsin, *Swezey*. Infrequent. South.

A. tuberculosa, Nutt. Triple-awned Grass.

Lapham. Pine barrens, St. Croix river, *Parry*. South.

SPARTINA, Schreber. CORD OR MARSH GRASS.

S. cynosuroides, Willd. Fresh-water Cord-Grass.

Abundant through the south half of the state and in the Red river valley; north of lake Superior, *Agassiz*; making up the greater part of the hay cut in sloughs, worth for fodder fully half as much as the hay of the uplands. Its hight is usually from two to four feet, but occasionally it is eight or nine feet. In the five or six counties next to the southwest corner of the state, because of the scarcity of wood and the high cost of that or coal for fuel, a large proportion of the people burn only hay during the whole year. For this purpose the coarse hay of this species is the only kind used. It is mostly burned in ordinary stoves, having been twisted, then doubled and again twisted, forming wisps about one and a half feet long. The quantity of this fuel required for a year's supply in an ordinary farm-house is from eight to twelve tons.

BOUTELOUA, Lagasca. MUSKIT-GRASS. GRAMA-GRASS.

B. oligostachya, Torr. Muskit-Grass. Grama.

Common, or frequent, southwestward and in the Red river valley; less frequent east to Stillwater and the edge of Wisconsin.

B. hirsuta, Lagasca. Muskit-Grass. Grama.

Common through the south part of the state, extending north to Minneapolis and the St. Croix river, *Parry*; abundant at New Ulm and in Rock and Pipestone counties.

This and the preceding are sometimes called Buffalo Grass in this state, a name which more properly belongs to Buchloe. See pages 14 and 32 of Rothrock's *Report on the Botany of Wheeler's Surveys west of the One Hundredth Meridian* for chemical analyses of Festuca ovina and the two foregoing species of Bouteloua, which with others of this genus are commonly called Grama in the southwestern United States.

B. racemosa, Lagasca. (B. curtipendula, Gray.) Muskit Grass. Grama.

Common through the south part of the state, especially southwestward; likewise in the Red river valley.

TOMA, from which it differs in its shorter, erect (not dichotomous) culms, and in its much larger flowers, and especially in the much longer, spreading, lateral awns. From A. GRACILIS it differs in the shorter panicle, the longer upper leaves with sheathed flowers, and in the flowers being twice as large. From A. RAMOSISSIMA it differs in wanting the larger size, the diffusely branched habit, the much larger flowers with 3- to 5-nerved glumes, and the strong recurved middle awn of that species. *Dr. George Vasey* in the *Botanical Gazette*, vol, ix, p. 76 (May, 1884).

*ARISTIDA PURPUREA, Nutt. Perennial; culms 6 to 15 inches high, simple, erect, slender, mostly glabrous; sheaths narrow, scabrous, exceeding the internodes, pilose at the throat; leaves very narrow, convolute, ½ to 10 inches long; panicle slender, erect or flaccid, 3 to 6 inches long, loosely few-flowered; glumes purplish, the upper 6 to 9 lines long, about twice exceeding the lower, and longer than the flower, bifid and shortly awned; flower densely short-pilose at the pointed base, scabrous above, 6 lines long, the awns equal or nearly so, separate to the base. not jointed, 1 to 2 inches long, scabrous. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

BUCHLOE, Engelm. BUFFALO GRASS.

B. dactyloides, Engelm.* Buffalo Grass.

Abundant in the vicinity of the pipestone quarry, at Pipestone City, commencing a few rods north of the railroad depot, and extending the whole length of the outcropping ledge of rock northward, in company with a dense growth of prickly pear (Opuntia Missouriensis and O. fragilis); also occurring, at rare intervals, on stony and gravelly soil, in Rock county, and in Lyon county, Iowa; (not found farther east; perhaps in all these places introduced by the Indians in their journeys from the western plains to the pipestone quarry;) *Leiberg*. [Formerly the most abundant species of grass throughout Nebraska, lately disappearing, according to *Aughey*, who attributes its dying out to increased rain-fall.]

GRAPHEPHORUM, Desv. GRAPHEPHORUM.

G festucaceum, Gray.† Graphephorum.

In Emmet county, Iowa, six miles south of the state line (plentiful upon space of five or six square rods, in edge of lake), *Cratty*; determined by *Prof. Asa Gray*; the first observation of this species in the United States, though it abounds in the Saskatchewan region and extends thence northward, and also is found in northern Europe. Doubtless it occurs in western and northern Minnesota. (*Botanical Gazette*, vol. ix, p. 27; Feb., 1884.)

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*BUCHLOE, Engelmann. Flowers diœcious, heteromorphous.——*Male plant*. Spikes 1-sided, 2-ranked; spikelets 2- or 3 flowered. Glumes 2, 1-nerved, lower much smaller. Palets 2, of equal length, longer than the glumes; lower one 3-nerved, mucronate; upper one 2-nerved. Squamulæ in pairs, truncate, emarginate. Stamens 3; anthers linear. Rudiment of an ovary none.——*Female plant*. Spikes 1 to 3, short, capitate, oblique in the involucrate sheaths of the upper leaves; spikelets 1-flowered, crowded, upper floret abortive, withering. Glumes 2; lower glume of the lowest spikelets 1- to 3-nerved, lanceolate-subulate, with an herbaceous tip, or 2- or 3-cleft, lower side adnate to the back of the upper glume; lower glumes of the other spikelets (internal as to the head) free, much smaller, membranaceous, ovate-lanceolate, acute, 1-nerved; upper glumes (external) connate at the base with the thickened rachis, at length like a hard, woody involucre, ovate, nerveless, pale, trifid at the herbaceous, nerved tip. Lower palet (internal as to the head) shorter, 3-nerved, herbaceous, tricuspidate; upper palet shorter, 2-nerved. Squamulæ as in the male flowers. Rudiments of the stamens 3, minute. Ovary lenticular, glabrous, very short-stipitate; stigmas much longer than the 2 erect terminal styles, plumose with simple hairs, exsert from the apex of the flower. Caryopsis free, included in a horny, at length deciduous head, sublenticular, flat on the outside (toward the lower palet), convex on the inner side.

B. DACTYLOIDES, Engelmann. *Trans. Saint Louis Acad.*, vol, i, p. 432, pl. 12 and 14. Densely tufted, spreading by stolons, forming broad mats; culms 3 to 6 inches long; flowering stems of the male plant 4 to 6 inches long, glabrous or slightly hairy; leaves 2 to 4 inches long, ½ to 1½ lines wide, nearly smooth; sheaths striate, glabrous, strongly bearded at the throat; spikes 3 to 6 lines long; spikelets alternate in 2 rows, uppermost abortive, bristle-form, 2 to 3 lines long; lower glume ovate-lanceolate, with a scarious margin; upper glume twice longer, ovate; lower palet convex, 3-nerved, upper one 2-nerved, two minute scales at the margin and inside of the lower palet; stamens 3. Stems of the female plant much shorter than the leaves, 1½ to 2 inches high; heads 3 to 3½ lines long; glumes becoming ligneous; spikes or heads usually 2; at maturity becoming thick, extremely hard, including the loose grain.——The celebrated "buffalo grass," known to hunters and trappers as one of the most nutritious grasses, on which for a part of the year subsist and fatten the immense herds of buffalo and the cattle of the hunter and emigrant. *Porter and Coulter's Flora of Colorado*.

†GRAPHEPHORUM FESTUCACEUM, Gray. (Festuca borealis, Mert. & Koch. Arundo festucacea, Willd.) Culm as thick as a swan's quill, 3 to 4 or more feet high; leaves 8 to 10 inches long, broadly linear-acuminate, rough to the touch. Panicle a foot and more long, almost quite erect, as well as the subverticillate slender branches.

DIARRHENA, Raf. DIARRHENA.

D. Americana, Beauv. Diarrhena.

Sherburne county, *Upham*. Rare. South.

DACTYLIS, L. ORCHARD GRASS.

D. glomerata, L. *Orchard Grass.*

Ramsey county, *Oestlund;* Minneapolis, *Simmons;* Mankato, *Leiberg.*

KŒLERIA, Pers. KŒLERIA.

K. cristata, Pers. Kœleria.

Common, or frequent, throughout the state. [The most plentiful species of grass on the line of the Northern Pacific railroad in western Dakota, *Leiberg*.]

EATONIA, Raf. EATONIA.

E. obtusata, Gray. Eatonia.

Minneapolis, *Upham;* Blue Earth county, *Leiberg*. [Manitoba, *Macoun*.] South and west.

E. Pennsylvanica, Gray. Eatonia.

Throughout the state, excepting perhaps northwestward. Ramsey county, *Oestlund;* Minneapolis, *Upham;* Blue Earth county, *Leiberg;* New Ulm, *Juni*. [North of lake Superior, *Agassiz*.]

GLYCERIA, R. Br. MANNA-GRASS.

G. Canadensis, Trin. Rattlesnake-Grass.

Frequent throughout the state, excepting far southward. St. Croix river, *Parry;* Ramsey county, *Oestlund;* Minneapolis, *Simmons*, *Kassube*.

G. elongata, Trin. Manna-Grass.

Minneapolis, *Upham;* Blue Earth county, *Leiberg*. Infrequent.

G. nervata, Trin. Fowl Meadow-Grass.

Common throughout the state.

[G. pallida, Trin., doubtless occurs in this state, but has been overlooked.]

G. aquatica, Smith, var. **Americana,** Vasey. Reed Meadow-Grass.

Common throughout the state.

Spikelets erect, ⅓ to ¾ of an inch long, scattered or subfascicled, sessile or pedicellate, generally 4-flowered. Glumes unequal, convex, rounded at the back, not keeled, the outer one shorter than the florets, acute, entire at the point, the middle nerve reaching beyond the point, so as to form a short arista; there are besides, on each side, two short lateral nerves; the inner glume as long as the whole spikelet of florets, torn at the point, aristate, the middle nerve reaching beyond the point; there are besides 2 lateral nerves reaching to the apex, and 2 intermediate shorter ones. Florets cylindrical, closely placed, with a tuft of white hairs at the base of each; outer valve [palet] of the perianth jagged at the point, shortly aristate, with 7 nerves reaching to the summit; the inner lanceolate, the margin inflected, with 2 strong, green, ciliated nerves at the flexures, running out so as to form a bifid apex; upper floret smaller than the rest. *Hooker's Flora Borealis Am.*, II, 251.——The Iowa specimens, communicated by Mr. R. I. Cratty, agree fully with this description, except that the spikelets are not so large, scarcely exceeding ¼ of an inch in length. Pedicels of the spikelets rough; awns formed by the nerves, especially of the glumes, inconspicuous, and sometimes barely observable. It grows 3 to 5 feet high in water, at the margin of lakes. *Arthur* in *Contributions to the Flora of Iowa, No. VI.*

G. fluitans, R. Br. Manna-Grass.

Common, or frequent, throughout the state.

POA, L. MEADOW-GRASS. SPEAR-GRASS.

P. annua, L. Low Spear-Grass.

Throughout the state, excepting perhaps far southward, but infrequent. Minneapolis, *Kassube;* Blue Earth county, *Leiberg.*

P. compressa, L. Wire-Grass.

Throughout the state, but infrequent. *Parry, Lapham.* Ramsey county, *Oestlund;* Blue Earth county, *Leiberg;* Pembina, *Chickering, Havard.*

P. alpina, L. Spear-Grass.

Isle Royale, and north shore of lake Superior, *Loring, Porter, Macoun;* doubtless also in Minnesota. North.

P. cæsia, Smith. Spear-Grass.

Throughout the state. North shore of lake Superior, *Juni;* Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty.*

P. cæsia, Smith, var. **strictior,** Gray. Spear-Grass.

Isle Royale, *Whitney;* Red river, *Dawson. Macoun.* North.

P. serotina, Ehrh. False Red-top. Fowl Meadow-Grass.

Common throughout the state.

P. pratensis, L. Green or Common Meadow-Grass. Kentucky Blue-Grass. June Grass.

Common throughout the state; taking the place of the original prairie grasses in southwestern Minnesota, *Juni.* [In Nebraska not native, but spreading westward, *Aughey.*]

P. sylvestris, Gray. Spear-Grass.

Lapham. Pembina, *Havard.* Rare. South and west.

[P. debilis, Torr., probably occurs in this state.]

P. alsodes, Gray. Spear-Grass.

Saint Paul, *Kelley;* Red river valley, at Pembina, *Chickering.* Infrequent. South and west.

ERAGROSTIS, Beauv. ERAGROSTIS.

E. reptans, Nees. Eragrostis.

Through the south part of the state. *Lapham.* Goodhue county, *Oestlund;* Blue Earth county, *Leiberg.*

E. poæoides, Beauv., var. **megastachya,** Gray. Eragrostis.

Abundant, in door-yards and by road-sides, through the south half of the state; common north at least to Crow Wing, Todd and Grant counties, and in the Red river valley, *Upham.* It was found by *Geyer* in 1839 on sandy plains in the valley of the Sheyenne river, Dakota, and is quite probably indigenous in this region.

E. pilosa, Beauv. *Eragrostis.*

Blue Earth county, *Leiberg;* Minneapolis (distinct from E. Purshii), *Upham.* Infrequent. South.

E. Frankii, Meyer. Frank's Eragrostis.

Hastings, Dakota county, *Oestlund.* Southeast

E. Purshii, Schrader. Pursh's Eragrostis.

Becoming abundant by road-sides and in waste places, Ramsey county, Minneapolis, and Steele county, *Oestlund*, *Simmons*, *Upham*; determined by *Scribner*, *Vasey* and *Watson*. South.

E. capillaris, Nees. Eragrostis.

Lapham Minneapolis, *Kassube*. Infrequent. South.

E. pectinacea, Gray. Eragrostis.

Lapham. Minneapolis, *Simmons*. South.

E. pectinacea, Gray, var. **spectabilis**, Gray. Eragrostis.

Minneapolis (river bluff near the University), *Oestlund*, *Upham*. South.

FESTUCA, L. FESCUE-GRASS.

F. tenella, Willd. Slender Fescue-Grass.

Through the south half of the state. *Lapham*. Minneapolis, *Simmons*, (abundant on sandy land east of the University) *Upham*.

F. ovina, L. Sheep's Fescue.

Frequent throughout the state, excepting perhaps far southward.

F. rubra, L. (F. ovina, L., var. rubra, Gray.) Red Fescue.

Lake Superior, *Dr. Robbins*, and northward, Gray's *Manual*; probably in northern Minnesota.

[F. duriuscula, L. (F. ovina, L., var. duriuscula, Gray), should also be looked for northward.]

F. elatior, L. (Including *F. pratensis*, Hudson.) *Taller or Meadow Fescue*.

Minneapolis, old state farm close southeast from University, *Oestlund*. Infrequent.

F. nutans, Willd. Nodding Fescue.

Throughout the state, excepting perhaps far northward, but infrequent. Lake Winnibigoshish, *Houghton*; lake Minnetonka, *Oestlund*; Blue Earth county, *Leiberg*; Emmet county, Iowa (rare), *Cratty*.

BROMUS, L. BROME-GRASS.

B. secalinus, L. *Cheat* or *Chess*.

Occasional in wheat-fields, mostly southeastward. A very unwelcome immigrant. Plentiful in Houston county, especially in fields of winter wheat, also frequent in mowing land, *J. S. Harris*; frequent, but not so plentiful as to be troublesome, in Steele county and at Minneapolis, *Upham*.

B. racemosus, L. *Upright Chess*.

Minneapolis, *Kassube*. Infrequent.

B. Kalmii, Gray. Wild Chess.

Common, or frequent, throughout the state, excepting perhaps northeastward.

B. ciliatus, L. Wild Chess.

Common, or frequent, throughout the state.

B. ciliatus, L., var. **purgans**, Gray. Wild Chess.

Minneapolis, *Upham*. Probably common.

PHRAGMITES, Trin. Reed.

P. communis, Trin. Reed.

Common, or frequent, in the edges of ponds and lakes, throughout the prairie portion of the state; also at Roseau lake and the lake of the Woods, *Dawson*.

SCHEDONNARDUS, Steudel.* SCHEDONNARDUS.

S. Texanus, Steud. (Lepturus paniculatus, Nutt.) Schedonnardus.

Rocky hills, Mound township, Rock county, *Leiberg*. [Upper Missouri river, *Geyer*.] Rare. Southwest.

LOLIUM, L. DARNEL. RAY-GRASS.

L. temulentum, L. *Bearded Darnel.*

Mankato (plentiful about the elevator of the St. Paul & Sioux City railroad), *Leiberg*.

AGROPYRUM, Beauv. (TRITICUM, L., in part.) WHEAT-GRASS.

A. repens, Beauv. (T. repens, L.) Couch-, Quitch-, Quick-, or Witch-Grass.

Frequent, or common, throughout the state, but rarely so plentiful as to be troublesome. (Specimens which must be referred to this species, as decided by *Mr. Sereno Watson*, were found at Minneapolis on the embankment of the railroad about an eighth of a mile northwest from the University and close west of Tuttle's brook, having a very narrow and long spike of many spikelets, awnless, as long or half as long as the joints of the rhachis, 3-flowered, with a rudiment of a fourth flower, often the lowest or the middle flower not ripening its grain, and having in some instances no running rootstocks. The typical T. repens occurs near by, and also forms which seem to be intermediate in respect to both the character of the spikes and the presence of rootstocks. *Upham*.)

A. dasystachyum, Vasey. (T. dasystachyum, Gray.) Wheat-Grass.

North shore of lake Superior, *Agassiz*; doubtless also in northern Minnesota.

A. violaceum, Vasey. (T. violaceum, Hornemann.) Wheat-Grass.

Throughout the state, but rarer than the next. Pembina, *Havard*; in openings of woods, on sandy modified drift, at the northwest side of Mille Lacs, *Upham*; Ramsey county, *Oestlund*; Emmet county, Iowa, *Cratty*.

A. caninum, Rœm. & Schultes. (T. caninum, L.) Wheat-Grass.

Frequent throughout the state, excepting perhaps far southward. Pembina, *Havard*; Minneapolis, *Twining*, *Upham*; Blue Earth county, *Leiberg*; New Ulm, *Juni*. [Between the James and Red rivers, Dakota, *Geyer*.]

HORDEUM, L. BARLEY.

H. jubatum, L. Squirrel-tail Grass.

Common, or frequent, throughout the state.

H. pusillum, Nutt. (H. pratense, Gray's *Manual*.) Barley-Grass.

Blue Earth county, *Leiberg*. Rare. South.

ELYMUS, L. LYME-GRASS. WILD RYE.

E. Virginicus, L. Wild Rye.

Frequent throughout the state; less common than the next.

E. Canadensis, L. Nodding Wild Rye.

Common throughout the state.

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*SCHEDONNARDUS, Steudel. Spikelets one-flowered, solitary at each joint of the slender triangular rhachis of the paniculate spikes, and partly immersed in an excavation; the spikes alternate and distant; outer glumes acuminate, unequal, the longer equaling the flowering glume, which is linear-acuminate, and thickish at the keel; palet shorter and thinner. *Vasey's Grasses of U. S.*

E. Canadensis, L., var. **glaucifolius**, Gray. Nodding Wild Rye.

Throughout the state. Lake of the Woods (sandy shore), *Dawson*; Martin county, and Emmet county, Iowa, *Cratty*.

E. Sibiricus, L. Wild Rye.

Red river valley, at Pembina, *Havard*. North.

E. striatus, Willd. Wild Rye.

Throughout the state. St. Croix river, *Houghton;* Ramsey county, *Oestlund;* Minneapolis, *Simmons;* Blue Earth county, *Leiberg;* New Ulm, *Juni;* Martin county (plentiful), *Cratty*. [Lake Superior, *Whitney;* Manitoba, *Macoun*.]

E. striatus, Willd., var. **villosus**, Gray. Wild Rye.

Also throughout the state. Pembina, *Havard;* lake Minnetonka, *Roberts;* Blue Earth county (frequent), *Leiberg*.

E. mollis, Trin. Wild Rye.

Lake shores [probably lake Superior], Minnesota, Wood's *Class-Book*. [North of lake Superior, *Agassiz*.]

E. Sitanion, Schultes.* Wild Rye.

From northern Minnesota to Texas and west to California, *Watson;* Blue Earth county and westward, *Leiberg*. West.

ASPRELLA, Willd. (GYMNOSTICHUM, Schreb.) BOTTLE-BRUSH GRASS.

A. Hystrix, Willd. (G. Hystrix, Schreb.) Bottle-brush Grass.

Common, or frequent, throughout the state.

DANTHONIA, DC. WILD OAT-GRASS.

D. spicata, Beauv. Wild Oat-Grass.

Throughout the state, but mostly infrequent. Lake of the Woods, *Dawson;* Stearns county, etc., *Upham;* Pipestone county, *Mrs. Bennett*.

AVENA, L. Oat.

A. fatua, L.† *Wild Oats.*

Ramsey county (new state farm and adjoining land, growing in grain-fields and on waste ground, apparently naturalized and spreading), *Oestlund*. Extensively naturalized in California; also found in Texas and Wisconsin, in the latter state becoming very troublesome in oat-fields, *Vasey;* but not yet reported (so far as known to the writer) in other portions of the United States east of the Rocky mountains. Its seeds ripen early and mostly fall before harvest, rendering its extermination more difficult. It is supposed to be the original of the cultivated oat (*A. sativa*, L.).

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*ELYMUS SITANION, Schultes. Culms 4 inches to 2 feet high, tufted, and with the leaves and sheaths glabrous or somewhat pubescent or scabrous; spike erect, 1 to 3 inches long, squarrose with its long recurved awns, jointed and fragile at maturity; spikelets in pairs, 2- to 5-flowered, smooth or puberulent; glumes entire or usually parted to the base and the segments unequally 2-cleft, the divisions long-awned (1 to 3 inches); flowers 3 lines long, the awn of the lower palet equaling that of the glumes, with often a subsidiary awn or tooth on each side at the apex of the palet. A very variable grass. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

†*Avena fatua*, L. An erect annual, 2 or 3 feet high, smooth except at the hairy nodes, with flat slightly scabrous leaves and loose sheaths: panicle 8 to 10 inches long, the few-flowered rays spreading equally; spikelets about an inch long, the scarious pointed glumes longer than the florets, often purplish at base: lower palet about 6 lines long, firm at base, scabrous and covered with long brown hairs, its lobes tapering to a sharp point; awn about twice the length of palet, bent near the middle and twisted below: grain very hairy. *Thurber* in *Botany of California*.

A. striata, Michx. Oat-Grass.

Throughout the state, excepting perhaps far southward. Isanti county, etc. (frequent), *Upham;* New Ulm, *Juni.*

A. Smithii, T. C. Porter. Oat-Grass.

Isle Royale, and eastward about lake Superior, Gray's *Manual;* probably also north of this lake in Minnesota.

TRISETUM, Persoon. TRISETUM.

T. subspicatum, Beauv., var. **molle**, Gray. Trisetum.

North of lake Superior (common), *Macoun.*

DESCHAMPSIA, Beauv. (AIRA, L., in part.) HAIR-GRASS.

D. cæspitosa, Beauv. (A. cæspitosa, L.) Hair-Grass.

Throughout the state, excepting perhaps far southward, but infrequent. Blue Earth county, *Leiberg.*

[D. flexuosa, Beauv. (A. flexuosa, L.), probably also occurs in this state.]

ARRHENATHERUM, Beauv. OAT-GRASS.

A. avenaceum, Beauv. *Tall Oat-Grass.*

New state farm, Ramsey county, *Oestlund.* Infrequent.

HIEROCHLOA, Gmelin. HOLY GRASS.

H. borealis, Rœm. and Schultes. Vanilla or Seneca Grass.

Common, or frequent, throughout the state.

PHALARIS, L. CANARY-GRASS.

P. Canariensis, L. *Canary-Grass.*

Occasionally adventive: Minneapolis, *Simmons, Upham;* Waterville, Le Sueur county, *Oestlund.*

P. arundinacea, L. Reed Canary-Grass.

Common, or frequent, throughout the state.

[Milium effusum, L., probably occurs in this state, but has been overlooked.]

BECKMANNIA, Host. BECKMANNIA. BECKMANN'S GRASS.

B. erucæformis, Host.* Beckmann's Grass.

Lapham. Pipestone quarry (growing in the hollows of the rock, where water occasionally stands), *Leiberg.* [James river, Dakota, *Geyer;* and north to the Saskatchewan river and Bear lake, *Watson.*] Rare. West.

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*BECKMANNIA, Host. Panicle racemose, contracted. Spikelets compressed, 2-flowered, the upper floret an abortive rudiment. Glumes 2, obovate, compressed-boatshaped, subcoriaceous, equal, a little shorter than the flower, pointless. Palets membranous, the lower ovate, concave, acutish, mucronate, 3-nerved, the upper 2-nerved, bifid. Stamens 3. Styles 2, with elongated plumose stigmas. Scales 2, bifid, glabrous. Grain free, glabrous.—A coarse perennial aquatic.

B. ERUCÆFORMIS, Host. Culms stout, 1 to 3½ feet high, erect from an ascending base, with the sheaths glabrous; ligules elongated; leaves linear, 4 to 8 inches long and 2 to 6 lines wide, flat, acute, scabrous; panicle 4 to 12 inches long, erect, strict, secund, the short crowded branchlets densely flowered from the base, glabrous; spikelets sessile, imbricately arranged in two rows, nearly orbicular, 1¼ lines in diameter, the upper rudimentary floret minute, stipitate. June to September. *Watson's Rep. in King's Expl. of the Fortieth Parallel.*

PANICUM, L. PANIC-GRASS.

P. glabrum, Gaudin. *Smooth Finger-Grass.*

Minneapolis (plentiful), *Simmons, Upham;* Blue Earth county, *Leiberg.*

P. sanguinale, L. *Common Crab-* or *Finger-Grass.*

Minneapolis, *Kassube;* Blue Earth county, *Leiberg.*

P. agrostoides, Spreng. Panic-Grass.

Lapham. Ramsey and Hennepin counties, *Oestlund.* South.

P. capillare, L. Old-witch Grass.

Common throughout the state. Late in autumn "the spreading panicle is easily broken off and blown about by the wind."

P. autumnale, Bosc. Panic-Grass.

Lapham. New Ulm, *Juni.* Rare. South.

P. virgatum, L. Panic-Grass.

Abundant southwestward and in the Red river valley; frequent southeastward. "Nowhere so luxuriant as near the upper Des Moines river and Spirit lake," *Geyer, Torrey.*

P. latifolium, L. Panic-Grass.

Through the south half of the state, but infrequent. Minnesota river, *Parry;* Blue Earth county, *Leiberg;* Minneapolis, *Simmons;* Anoka county, etc., *Upham.*

[P. clandestinum, L., probably also occurs in this state.]

P. xanthophysum, Gray. Panic-Grass.

Throughout the state. Minneapolis, *Kassube;* Steele and Isanti counties, *Upham.* [Manitoba, *Macoun;* also in the catalogues of Wisconsin, Iowa and Nebraska.]

P. consanguineum, Kunth, var. **latifolium,** Vasey, ined.* Panic-Grass.

New state farm, Ramsey county, *Oestlund.* Probably frequent; resembling P. xanthophysum, so that perhaps some of the references under that species belong instead to this.

P. pauciflorum, Ell. Panic-Grass.

Throughout the state, excepting perhaps northeastward. Red river (swampy prairie), *Dawson;* Ramsey county, *Oestlund;* Minneapolis, *Upham;* Blue Earth county, *Leiberg;* Emmet county, Iowa (common), *Cratty.*

P. dichotomum, L. Panic-Grass.

Common, or frequent, throughout the state. [Specimens collected in early summer by *Mr. Oestlund* on the new state farm, Ramsey county, are regarded by *Dr. Vasey* as representing the typical form of this species. It occurs intermingled with other grasses on lowlands: mainly smooth; culms slender, 1½ feet high; panicle long-peduncled.]

P. dichotomum, L., var. **pubescens,** Vasey, ined. (P. pubescens, Lam.) Panic-Grass.

Ramsey and Hennepin counties (usually about a foot high, becoming much branched), *Oestlund, Upham;* probably the more common form of the species in this state. Gray's *Manual* characterizes it as "a shaggy-hairy and larger-flowered variety." [Culm rather leafy, 1 to 2 feet high; leaves and sheaths decidedly pubescent or villous. *Letter of Dr. Vasey,* Sept. 30, 1884.]

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*PANICUM CONSANGUINEUM, Kunth. Smooth or villous; culms (1 to 1½ feet high) at length excessively branched; leaves linear, erect; panicle long-peduncled, the flexuous widely spreading branches few-flowered; spikelets obovate, pale, pubescent; upper glume 7-nerved; upper palea of the neutral flower none; perfect flower acute. *Chapman's Flora of the Southern States,* appendix, p. 667.——Var. LATIFOLIUM, Vasey, ined. Culms weaker, leaves wider, and flowers more pubescent. Minnesota, *Oestlund. Letter of Dr. Vasey,* Sept. 30, 1884.

[Two others of the forms included under P. dichotomum in Gray's *Manual*, but separated from it by appendix of Chapman's *Flora of the Southern States*, with the descriptions here quoted, are recognized by Dr. Vasey (*Grasses of U. S.*) as distinct species, namely, P. LAXIFLORUM, Lam. (culms tufted, smooth, 6 to 12 inches high; leaves lanceolate, acuminate, ciliate, mostly pale yellowish-green, 2 to 3 inches long, the villous sheaths shorter than the internodes; panicle diffuse, plumose-bearded, rather few-flowered; spikelets scattered, oval, densely pubescent, the upper glume 7-nerved; neutral flower bipaleaceous; fertile flower acute: on dry sandy ground), and P. RAMULOSUM, Michx., in part (low, 6 to 8 inches high, tufted, very smooth and shining; culm mostly purple; leaves linear; panicle 1½ to 2 inches long, diffusely branched, many-flowered: spikelets minute, purple, very smooth, the upper glume and neutral palet 5-nerved: in sandy woodlands); both of which are common in the eastern states, but have not yet been observed so far northwestward as Minnesota.]

P. depauperatum, Muhl. Panic-Grass.

Throughout the state. *Lapham*. Blue Earth county, *Leiberg;* Emmet county, Iowa, *Cratty*. [Lake Superior, *Whitney;* Manitoba, *Macoun*.]

P. Crus-galli, L. *Barnyard-Grass.*

Common throughout the state.

P. Crus-galli, L., var. **hispidum,** Gray. Cockspur Grass.

Rock and Pipestone counties, etc. (frequently seen attaining a very rank growth beside roads where they cross creeks or boggy land, apparently indigenous), *Leiberg*.

SETARIA, Beauv. BRISTLY FOX-TAIL GRASS.

S. verticillata, Beauv. *Bristly Fox-tail Grass.*

Mankato, *Leiberg*. Rare.

S. glauca, Beauv. "*Pigeon-Grass.*" *Foxtail.*

Common, often abundant, throughout the state.

S. viridis, Beauv. "*Pigeon-Grass.*" *Green Foxtail. Bottle-Grass.*

Also common, or abundant, in cultivated ground, with the last.

S. Italica, Kunth. *Millet. Bengal-Grass.*

Becoming a bad weed in flax-fields in the southern part of the state, *Leiberg;* New Ulm, *Juni*.

CENCHRUS, L. HEDGEHOG-GRASS. BUR-GRASS.

C. tribuloides, L. "Sand-bur." Hedgehog-Grass. Bur-Grass.

Common, or frequent, in sandy lands along the Mississippi and Minnesota rivers. (Occasionally attacked by smut, as at Minneapolis in 1884.)

ANDROPOGON, L. BEARD-GRASS.

A. furcatus, Muhl. "Blue-Joint." Beard-Grass. Forked Spike.

Common, or abundant, throughout the prairie region of the state; extending northeast at least to Crow Wing county, *Upham*, and the lake of the Woods, *Dawson*. Highly esteemed for hay; southwestward it is usually called "Blue-Joint," a name which properly belongs to Deyeuxia Canadensis.

A. scoparius, Michx. Beard-Grass. Broom-Grass.

Common, with same range as the last.

CHRYSOPOGON, Trin.* CHRYSOPOGON. BEARD-GRASS.

C. nutans, Benth. (Sorghum nutans, Gray.) Indian Grass. Wood-Grass.

Common, with same range as the two last; making good hay.

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* CHRYSOPOGON, Trin. Flowers loosely paniculate. Fertile spikelets one-flowered, sessile between two pedicellate male or barren spikelets at the end of the slender

EQUISETACEÆ. HORSETAIL FAMILY.

EQUISETUM, L. HORSETAIL. SCOURING-RUSH.

[E. Telmateia, Ehrh., probably occurs in this state north of lake Superior.]

E. arvense, L. Common Horsetail.

Common throughout the state.

E. pratense, Ehrh. Meadow Horsetail.

Throughout the state, excepting perhaps far southward. Morrison county, *Upham;* Stearns county, *Campbell;* Saint Paul, *Kelley.*

E. sylvaticum, L. Wood Horsetail.

Throughout the state: common northward, but infrequent far southward.

[E. palustre, L., will probably be found in the north part of the state.]

E. limosum, L. Swamp Horsetail.

Common, or frequent, throughout the state.

E. lævigatum, Braun. Horsetail.

Minneapolis, *Simmons, Upham;* Red river, near Saint Vincent, *Dawson, Scott.* South and west.

E. hiemale, L. Scouring-Rush. Shave-Grass.

Common throughout the state; very abundant along the banks of the Minnesota river, *Parry.*

E. variegatum, Schleicher. Horsetail.

Throughout the state, excepting perhaps far southward. Near the Mississippi river, Anoka county, *Upham;* Minneapolis, *Simmons.* Infrequent.

E. scirpoides, Michx. Horsetail.

Range like the last, also infrequent. *Lapham.* Deep woods, St. Croix river, *Parry.*

FILICES. FERNS.

POLYPODIUM, L. POLYPODY.

P. vulgare, L. Common Polypody.

Abundant, or common, through the north half of the state; frequent southeastward, on the rocky bluffs of the St. Croix, Mississippi and Minnesota rivers, and their tributaries; rare southwestward.

ADIANTUM, L. MAIDENHAIR.

A. pedatum, L. American Maidenhair.

Frequent, in many places common or abundant, throughout the state.

PTERIS, L. BRAKE or BRACKEN.

P. aquilina, L. Common Brake. Bracken. Eagle Fern.

Common, or frequent, throughout the state.

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branches of the panicle, with, sometimes, one to three pairs of spikelets on the branch below the terminal three. Fertile spikelets with the lower glume larger and coriaceous; the second narrower, thick, keeled, pointed or awned; the third hyaline and empty; the fourth or flowering glume hyaline and awned. Palet minute or none. *Vasey's Grasses of U. S.*

CHEILANTHES, Swartz. LIP-FERN.

C. lanuginosa, Nutt. Lip-Fern.

Lapham, Miss Cathcart. Falls of the St. Croix, *Parry*. Rare.

PELLÆA, Link. CLIFF-BRAKE.

P. gracilis, Hook. Slender Cliff-Brake.

Throughout the state, but rare. Blue Earth river, and head of lake St. Croix, *Parry;* Saint Paul (rare), *Miss Cathcart;* cliffs forming the right bank of the Mississippi in Minneapolis, also at Minneopa falls, Blue Earth county, *Leiberg*; lake Pepin, *Miss Manning;* Martin county, and Emmet county, Iowa (rare), *Cratty*.

P. atropurpurea, Link. Clayton's Cliff-Brake.

Throughout the state, but infrequent. Stillwater, *Miss Field;* Saint Paul, *Miss Cathcart;* Hastings, *Oestlund;* lake Pepin, *Miss Manning;* Blue Earth county, *Leiberg*.

CRYPTOGRAMME, R. Br. (ALLOSORUS, Bernhardi, in part.) ROCK-BRAKE.

C. acrostichoides, R. Br. (Allosorus acrostichoides, Sprengel.) Rock-Brake.

Isle Royale, lake Superior, thence westward and northward, Gray's *Manual;* doubtless in Minnesota.

ASPLENIUM, L. SPLEENWORT.

A. Trichomanes, L. Maidenhair Spleenwort. Dwarf Spleenwort.

Burnt Portage, Dawson road, near the northern boundary of Minnesota, *Macoun;* Taylor's Falls, *Miss Cathcart;* Lake City, *Mrs. Ray*. Throughout the state, but infrequent.

A. ebeneum, Ait. Ebony Spleenwort.

Taylor's Falls, *Miss Cathcart*. Rare. [Nebraska, *Aughey*.]

[A. Ruta-muraria, L., and A. angustifolium, Michx., should be looked for in this state.]

A. thelypteroides, Michx. Silvery Spleenwort.

St. Croix river, *Parry;* Stillwater, *Miss Field;* lake Pepin, *Miss Manning;* Blue Earth county, *Leiberg*. East.

A. Filix-fœmina, Bernh. Lady-Fern.

Common (having diverse forms, but probably not permanent varieties) in woodlands throughout the state.

CAMPTOSORUS, Link. WALKING-LEAF. WALKING-FERN.

C. rhizophyllus, Link. Walking-Leaf. Walking-Fern.

Throughout the state, but rare. Rocks, upper Mississippi river, *Geyer;* falls of the St. Croix, *Parry;* Taylor's Falls and Duluth, *Miss Cathcart;* Stillwater, *Miss Field;* Red Wing, *Oestlund;* lake Pepin, *Miss Manning*. [Manitoba, *Macoun;* Nebraska, *Aughey*.]

PHEGOPTERIS, Fée. BEECH-FERN.

P. polypodioides, Fée. Common Beech-Fern.

Abundant north of lake Superior, *Roberts;* extending south to the St. Croix river, *Parry;* Taylor's Falls (plentiful), *Miss Cathcart*. [Manitoba, *Macoun;* Nebraska, *Aughey*.]

P. hexagonoptera, Fée. Hexagon Beech-Fern.

Duluth (plentiful), *Miss Cathcart;* and through the south half of the state, but rare.

P. Dryopteris, Fée. Oak-Fern.

North of lake Superior (common), *Roberts;* St. Louis river, *Mrs. Herrick;* St. Croix river, *Parry, Miss Field;* Taylor's Falls (plentiful), Saint Paul (rare), *Miss Cathcart.* [Manitoba, *Macoun.*]

P. calcarea, Fée.* (P. Dryopteris, Fée, var. Robertianum, Davenport.) Beech-Fern.

"Collected in eastern Minnesota, growing on slaty rocks on the [west] bank of the St. Louis river, near [close north of] the crossing of the Northern Pacific Railway, by *Miss Ellen W. Cathcart.* Formerly attributed to America, but not clearly known as American till now. It is rather common in Europe, and has been found in the Himalayan regions of Asia. It will probably be found from Lake Superior to Idaho. This fern is very closely related to the common P. Dryopteris, and is often considered a variety of it." *Eaton's Ferns of North America*: 1880; vol. ii, p. 277. Since this was written, a second locality of this fern has been discovered by *Mr. E. W. Holway* at Decorah, Iowa, where it occurs only upon a space about six feet square, "in the crevices of the north side of a limestone bluff." *Arthur*; *Bulletin of Torrey Botanical Club*, vol. ix, p. 50. Still more recently it has been collected by *Prof. J. Macoun* in Anticosti island, and by *Drs. G. M. Dawson* and *R. Bell* in the country around and to the east of the lake of the Woods. *Science*, vol. iii, p. 676 (June 6, 1884).

ASPIDIUM, Swartz. SHIELD-FERN. WOOD-FERN.

A. Thelypteris, Swartz. Marsh Shield-Fern.

Common, or frequent, throughout the state.

A. Noveboracense, Swartz. New York Shield-Fern.

Stearns county, *Campbell;* lake Pepin, *Miss Manning.* Infrequent. East.

A. fragrans, Swartz. Fragrant Wood-Fern.

Isle Royale, *Dr. Lyons;* Duluth and Taylor's Falls, *Miss Cathcart;* Kettle river in T. 42, R. 20, Pine county, *Upham;* falls of the St. Croix, *Parry;* Pipestone quarry, *Mrs. Bennett.* [Nebraska, *Aughey.*] North and southwest.

A. spinulosum, Swartz. Spinulose or Common Wood-Fern.

Throughout the state, but rare. *Lapham.* Duluth, *Miss Cathcart;* lake of the Woods, *Dawson.*

A. spinulosum, Swartz, var. **intermedium,** Eaton. Spinulose or Common Wood-Fern.

Common, or frequent, throughout the state, excepting far southward. Ramsey county, *Simmons;* Pine county, etc., *Upham.* [North of lake Superior, *Agassiz;* Nebraska, *Aughey.*]

A. spinulosum, Swartz, var. **dilatatum,** Hornemann. Spinulose or Common Wood-Fern.

Throughout the state, excepting far southward. Falls of the St. Croix, *Parry;* Duluth, *Miss Cathcart;* Cascade river, north of lake Superior, *Roberts.* [Manitoba, *Macoun;* Nebraka, *Aughey.*]

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*PHEGOPTERIS CALCAREA, Fee. Rootstock slender, cord-like, widely creeping; stalks scattered, slender, glandular, chaffy near the base, six to twelve inches high; fronds herbaceous, rather rigid, minutely glandular, deltoid, four to eight inches long and about as broad at the base, ternate; primary divisions stalked, pinnate with oblong or ovate-oblong pinnæ, which are pinnately lobed or divided; lowest inferior pinna of the lateral divisions about equal to the third pinna of the middle division; lobes oblong, obtuse, crenately toothed, or if very large, pinnately lobed; veins pinnately branched, sori small, nearer the margin than the midvein. *Eaton's Ferns of N. A.*

A. Boottii, Tuckerman. (A. spinulosum, Swartz, var. Boottii, Gray.) Boott's Wood-Fern.

Kanabec county, *Upham*. Infrequent.

A. cristatum, Swartz. Crested Wood-Fern.

Throughout the state; frequent northward, rare southward. St. Croix river, *Parry;* Minneapolis, *Simmons;* Saint Paul and lake Harriet (near Minneapolis), *Miss Cathcart;* Blue Earth county, *Leiberg*. [Extending northwest to lake Winnipeg, *Eaton;* Nebraska, *Aughey*.]

A. Goldianum, Hook. Goldie's Wood-Fern.

Minnesota, *Davenport;* Minneopa falls, Blue Earth county, *Leiberg*. Rare. East.

A. Filix-mas, Swartz. Male-Fern.

North shore of lake Superior, near Beaver Bay, *Campbell*. Rare. North.

A. marginale, Swartz. Marginal Shield-Fern. Evergreen Wood-Fern.

Lapham, Davenport. Infrequent. [Nebraska, *Aughey*.]

A. acrostichoides, Swartz. Christmas-Fern.

Lapham, Miss Cathcart. Fort Snelling, *Parry*. East.

A. Lonchitis, Swartz. Holly-Fern.

South of lake Superior, *Whitney;* doubtless also north of this lake in Minnesota. [Nebraska, *Aughey*.]

[A. aculeatum, Swartz, var. Braunii, Doell, will also probably be found in the northeast part of this state.]

CYSTOPTERIS, Bernhardi. BLADDER-FERN. CYSTOPTERIS.

C. bulbifera, Bernh. Bulblet Cystopteris.

Frequent, or common, throughout the state.

C. fragilis, Bernh. Brittle Fern.

Also frequent, or common, throughout the state. Very variable; the form named var. dentata, Hook., has been observed at Cascade river, north of lake Superior, *Roberts;* Taylor's Falls, *Miss Cathcart;* and in Iowa (common), *Arthur*.

C. montana, Bernh. Bladder-Fern. Cystopteris.

In a swamp at the silver mine three miles up the bay from Port Arthur, *Macoun;* probably also to be found north of lake Superior in Minnesota. [Deltoid-ovate, delicately tripinnate, and almost quadripinnate fronds, and a long, slender, creeping rootstock. *Eaton* in *Wheeler's Report of Surveys west of the One Hundredth Meridian*.]

ONOCLEA, L. SENSITIVE FERN.

O. Struthiopteris, Hoff. (Struthiopteris Germanica, Willd.) Ostrich-Fern.

Common, or frequent, throughout the state, excepting southwestward.

O. sensibilis, L. Sensitive Fern.

Common throughout the state, excepting perhaps near its west side. (A frond eighteen inches high, sterile on one side of the stipe, but wholly fertile on the other side, was found by the writer in Todd county The form called var. obtusilobata, Torr., has been noted at Taylor's Falls, *Miss Cathcart*, and Mankato, *Gedge*.)

WOODSIA, R. Br. WOODSIA.

W. obtusa, Torr. Obtuse Woodsia.

Throughout the state, but local. Taylor's Falls [falls of the St. Croix], *Parry*, (abundant) *Miss Cathcart, Miss Field;* Rock county, *Leiberg;* Pipestone quarry, *Mrs. Bennett.* [Manitoba, *Macoun;* Nebraska, *Aughey.*]

W. Ilvensis, R. Br. Rusty Woodsia.

Throughout the state, excepting far southward. North of lake Superior (abundant), *Roberts;* lake of the Woods, *Dawson;* Taylor's Falls and Duluth (common), *Miss Cathcart, Miss Field;* Stearns county, *Mrs. Blaisdell;* upper Minnesota river, *Parry;* Redwood Falls, *Miss Butler*. "A dwarf form, one to three inches high, yet fruiting freely, was common in the clefts of the rocks on the summit of Carlton's Peak." *Roberts.*

[W. hyperborea, R. Br., found by *Prof. Macoun* on the north shore of lake Superior, should be looked for in northern Minnesota. It is nearly related to W. Ilvensis, but is tenderer in its texture, much less chaffy, and narrower in outline, with shorter, more obtuse, and less divided pinnæ. *Eaton's Ferns of N. A.*]

W. glabella, R. Br. Smooth Woodsia.

North of lake Superior (at Kakabeka falls), *Macoun;* doubtless also to be found in northern Minnesota; Stillwater, *Miss Field.*

W. Oregana, Eaton. Oregon Woodsia.

South shore of lake Superior and westward [Keweenaw peninsula and lake Winnipeg]; doubtless in northern Minnesota; also at Stillwater, *Miss Field.*

W. scopulina, Eaton.[*] Rocky Mountain Woodsia.

Collected by *Miss Cathcart* at Duluth, and at Taylor's Falls on the St. Croix river; Lyons creek below Minneopa falls, Blue Earth county, *Gedge.* "Growing in dense masses on rocks and in crevices, from Oregon to Mono Pass, California, and extending eastward to Dacotah, Minnesota and Colorado. . . . The largest specimens are from Minnesota and Colorado." *Eaton's Ferns of North America.*

DICKSONIA, L'Her. DICKSONIA.

D. pilosiuscula, Willd. (D. punctilobula, Kunze.) Fine-haired Mountain Fern. Hay-scented Fern.

Miss Cathcart. Stearns county, *Campbell;* lake Pepin, *Miss Manning.* Rare. Southeast.

OSMUNDA, L. FLOWERING FERN.

O. regalis, L. Royal-Fern. Flowering Fern.

Frequent throughout the state, excepting far southward. North of lake Superior (common along Devil's Track river), *Roberts;* Anoka county, etc., *Upham;* Saint Paul and northward, *Miss Cathcart, Miss Field.*

O. Claytoniana, L. Clayton's (Interrupted) Flowering Fern.

Common, or frequent, throughout the state.

O. cinnamomea, L. Cinnamon-Fern.

Throughout the state, excepting perhaps northwestward. Common north of lake Superior and at Minneapolis, *Roberts;* Anoka county, etc., *Upham;* Taylor's Falls, *Miss Cathcart, Miss Field;* Northfield, Rice county, *Chaney;* lake Pepin, *Miss Manning.*

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[*] WOODSIA SCOPULINA, Eaton. Root-stocks short, creeping, chaffy, forming large tufts or patches; stalks two to four inches high, not jointed, bright ferruginous near the base, paler and stramineous upwards, puberulent like the rachis and the under surface of the frond, with minute jointed hairs and stalked glands; fronds lanceolate-oblong, four to eight inches long, pinnate; pinnæ numerous, eight to fifteen lines long, oblong-ovate, sub-acute, deeply pinnatifid with five to eight pairs of short ovate or oblong obtuse crenulate or toothed divisions; sori sub-marginal; indusium very delicate, deeply cleft into narrow segments which terminate in short hairs composed of irregular cylindrical cells. . . . Nearly like W. Oregana. *Eaton's Ferns of N. A.*

OPHIOGLOSSACEÆ. Adder's-Tongue Family.

BOTRYCHIUM, Swartz. Grape-Fern. Moonwort.

B. Lunaria, Swartz. Moonwort.

North shore of lake Superior, *Macoun;* doubtless to be found in northern Minnesota.

B. simplex, Hitchcock. Hitchcock's Grape-Fern.

Thomson, Carlton county (rare), *Miss Cathcart.* [Abundant at Fort William, north of lake Superior, *Macoun.*] North.

[B. lanceolatum, Angstrœm, and B. matricariæfolium, Braun, probably occur in northeastern Minnesota. The latter is distinguished from B. lanceolatum by having the sterile segment petioled, diverging but little and embracing the fertile when young, oblong and only in the largest plants deltoid, with its divisions and lobes oblong or ovate and obtuse; panicle with stalk usually half as long as the sterile segment, and sometimes longer than it; and by its fruiting two or three weeks earlier. *Eaton's Ferns of N. A.*]

B. Virginianum, Swartz. Virginia Grape-Fern. Rattlesnake Fern.

Frequent, or common, throughout the state.

B. ternatum, Swartz. (B. lunarioides, Swartz. B. australe, R. Br.) Ternate Grape-Fern.

Throughout the state, but infrequent. St. Croix river, *Parry;* St. Croix Falls (rare), *Miss Field;* lake Pepin, *Miss Manning;* near Lake Crystal (station now obliterated), *Letberg;* lake of the Woods at mouth of Rainy river, *Dawson.* [Var. obliquum, Milde, and var. dissectum, Milde, probably also occur in this state.]

OPHIOGLOSSUM, L. Adder's Tongue.

O. vulgatum, L. Adder's-Tongue.

Lake of the Woods at mouth of Rainy river, with the last, *Dawson.* Rare.

LYCOPODIACEÆ. Club-Moss Family.

LYCOPODIUM, L. Club-Moss. Trailing Evergreen.

L. lucidulum, Michx. Shining Club-Moss.

Mouth of Devil's Track river, lake Superior, and on Carlton's Peak (abundant), *Roberts;* lake of the Woods, *Dawson;* Kettle river, Pine county (common), *Upham;* St. Croix river, *Parry;* Blue Earth county, *Letberg.* [Hesper, Iowa, *Mrs. Carter;* the sole species of this genus, and its only locality, known in Iowa, *Arthur.*] North.

L. Selago, L. Fir Club-Moss.

North shore of lake Superior, *Juni, Roberts.* Rare. North.

L. inundatum, L. Marsh Club-Moss.

Palisades, north shore of lake Superior, *Juni;* Stillwater, *Miss Butler.* North.

L. annotinum, L. Club-Moss.

Common through the north part of the state; extending southwestward to Pine county (common), *Upham,* and the sources of the Mississippi, *Houghton.*

L. dendroideum, Michx. Tree-like Club-Moss. Ground-Pine.

Common northward, extending southwest to Wadena county; the most plentiful species of club-moss in Pine county, *Upham.*

L. clavatum, L. Common Club-Moss.

Common northward, extending thus south at least to Pine county.

L. complanatum, L. Club-Moss. Festoon Ground-Pine.

Common northward; extending south to Wadena and Pine counties (next in abundance after L. dendroideum, Michx.), *Upham*. This and the three species next preceding are bounded within nearly the same limits as the pines, spruce and fir.

L. complanatum, L., var. **sabinæfolium**, Spring. Club-Moss. Ground-Fir.

Frequent far northward; upper Mississippi river, *Garrison*.

SELAGINELLEÆ.

SELAGINELLA, Beauv. DWARF CLUB-MOSS. SELAGINELLA.

S. selaginoides, Link. Dwarf Club-Moss.

Isle Royale, *Dr. Lyons*; north shore of lake Superior, *Macoun*; doubtless to be found in northern Minnesota.

S. rupestris, Spring. Dwarf Club-Moss.

Throughout the state. Lake of the Woods, *Dawson*; Morrison, Benton and Stearns counties, *Upham*; upper Minnesota river and falls of the St. Croix, *Parry*; Blue Earth county, *Leiberg*; Redstone, near New Ulm, *Juni*; Redwood Falls, *Miss Butler*; Pipestone quarry, *Mrs. Bennett*.

[S. apus, Spring, will probably be found in the south part of the state.]

[Isoetes lacustris, L., I. echinospora, Durieu, var. Braunii, Engelm., I. riparia, Engelm., and I. melanopoda, J. Gay, should be looked for in this state.]

MARSILIACEÆ.

MARSILIA, Lam. MARSILIA.

M. vestita, Hook. & Grev.[*] Marsilia.

"Dry swamps in the prairies near Devil's lake," in northeastern Dakota, *Geyer*; "near the Mississippi river," in Iowa, *Dr. Cousens*; probably also in Minnesota. (See notes on this species in *Arthur's Contributions to the Flora of Iowa, No. VI.*)

[Prof. Eaton writes that the Marsilia cited as collected by Geyer is the original of M. mucronata, Braun; but it is regarded by Prof. Eaton as a form of M. vestita, as at first determined by Dr. Torrey, differing from the ordinary type in having longer peduncles and less hairy sporocarps. M. uncinata, Braun, is found, according to Prof. Eaton, in Texas, Louisiana and Florida.]

SALVINIACEÆ.

AZOLLA, L. AZOLLA.

A. Caroliniana, Willd. Azolla.

Lapham. [The range of this species is stated by *Prof. Eaton* in the *Botany of California* to be from "Oregon to Arizona, eastward to the Atlantic, and southward to Brazil."]

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[*] MARSILIA VESTITA, Hook. & Grev. Leaflets broadly cuneate, usually hairy, entire, 2 to 7 lines long and broad; petioles 1 to 4 inches long; peduncles free from the petiole; sporocarps solitary, short-peduncled, about 2 lines long, very hairy when young; upper tooth longest, acute, straight or curved; lower tooth obtuse, the sinus between them rounded. . . . Oregon to Texas. *Eaton* in *Botany of California*.

APPENDIX.

Since the date of the acknowledgments made on page 10, contributions to this catalogue have been received from Mrs. C. L. Herrick, of Minneapolis; Mr. A. W. Jones, of the state university; Mr. W. H. Kelley, of Saint Paul; and Mr. O. W. Oestlund, of Minneapolis. Three varieties of grasses, described by Dr. Vasey, are first published, with his permission, on pages 161 and 172. Mr. Kelley also supplied a copy of notes on the "Botany of Winona county," by J. C. Norton, M. D., printed in the *Winona Republican*, July 14 to Sept. 22, 1857, including a list of 211 species. Several of these are accessions to the foregoing catalogue, while for other species their known geographic range in this state is extended. Items from this source, and others sent by correspondents too late for insertion in their regular places, are as follows:

Nasturtium obtusum, Nutt. Water-Cress.

Winona county, *Norton*; Minnehaha falls, *Miss Butler*. South.

Cardamine rotundifolia, Michx. (Including C. rhomboidea, var. purpurea, Torr.) Mountain Water-Cress.

Winona county, *Norton*. Infrequent.

Arabis petræa, Lam. Rock Cress.

Winona county, *Norton*. [Ranging from southern Michigan to the shores of lake Superior, Isle Royale, and far northward.]

Hypericum perforatum, L. *Common St. John's-wort.*

Winona county, *Norton*. Infrequent. South.

Stellaria uliginosa, Murr. Swamp Stitchwort.

Fond du Lac, at west end of lake Superior, *Mrs. Herrick*. North.

Cassia Marylandica, L. Wild Senna.

Winona county, *Norton*. Infrequent. South.

Cassia nictitans, L. Wild Sensitive-Plant.

Lily lake, Stillwater, *Miss Butler*. Rare. South.

AMMANNIA humilis, Michx. Ammannia.

Lake City, *Gibson*. Infrequent. South.

Cornus florida, L. Flowering Dogwood.

Upper Mississippi river, *Garrison*; northern Minnesota, *Sargent's Catalogue of the Forest Trees of N. A.*; Ramsey county, *Winchell*. Rare. South.

Lepachys columnaris, Torr. & Gray, var. **pulcherrima**, Torr. & Gray. Lepachys.

Red river valley near Saint Vincent, *Scott*. West. [Differs only in having a part or even the whole upper face of the ray brown-purple; varies southward into more slender and branching forms, some with rays reduced to a quarter-inch. *Gray's Synoptical Flora of N. A.*]

Quercus nigra, L. Black Jack or Barren Oak.

Southern Minnesota, *Sargent's Catalogue of the Forest Trees of N. A.*

Additional Localities.

Nelumbium luteum, Willd.; in lake Pepin near Frontenac, *Miss Manning, Mrs. Ray.*

Cardamine pratensis, L.; Winona county, *Norton.*

Oxalis Acetosella, L.; Winona county, *Norton.* [Extending south in Michigan to lake St. Clair.]

Trifolium hybridum, L.; Minneapolis, *A. W. Jones.*

Desmodium rotundifolium, DC.; Winona county, *Norton.*

Vicia sativa, L.; Washington county, Minneapolis and Saint Cloud.

Spiræa tomentosa, L.; Winona county, *Norton.*

Myriophyllum heterophyllum, Michx.; West Saint Paul, *Miss Butler.*

Œnothera fruticosa, L.; Winona county, *Norton*; Waseca county, *Miss Thrall.*

Berula angustifolia, Koch; Winona county (abundant in cold spring brooks, and most abundant in the coldest water), *Norton.*

Cephalanthus occidentalis, L.; Winona county, *Norton.*

Houstonia purpurea, L., var. ciliolata, Gray; Winona county, *Norton.*

Solidago ulmifolia, Muhl.; Rice county (rare), *Chaney.*

Ambrosia trifida, L., var. integrifolia, Torr. & Gray; common in the Red river valley, *Leiberg.*

Helianthus hirsutus, Raf.; Rice county, *Chaney.*

Coreopsis trichosperma, Michx.; Saint Cloud, *Campbell.*

Lobelia cardinalis, L.; Owatonna, Steele county, *Chaney.*

Asclepias verticillata, L.; add: common southwestward.

Cycloloma platyphyllum, Moquin; bank of Cannon river, Northfield, Rice county, *Chaney.*

Chenopodium capitatum, Watson; Stockton quarries, near Winona, *Holzinger.*

Frœlichia Floridana, Moquin; near Red Wing, *Sandberg.*

Polygonum Virginianum, L.; Ramsey county, *Oestlund.*

Dioscorea villosa, L.; Red river valley, *Leiberg.*

Sporobolus asper, Kunth; Minneapolis, *Oestlund.*

Corrections in Nomenclature.

Prof. C. S. Sargent has kindly permitted the perusal of proofs of his *Catalogue of the Forest Trees of North America*, a report soon to be published for the Tenth Census of the United States, according to which several changes in nomenclature are required by species in this catalogue, making them read thus: QUERCUS OBTUSILOBA, Michx.; Q. PRINOIDES, Willd., (Q. Prinus, vars. acuminata, Michx., and humilis, Marshall); BETULA PAPYRIFERA, Marshall (B. papyracea, Ait.); ALNUS INCANA, Willd. [only the type occurs here, while var. virescens, Watson (var. glauca, Regel, in part), ranges from the Saskatchewan to British Columbia, and thence south in the mountains to New Mexico]; ALNUS SERRULATA, Willd.; and ABIES BALSAMEA, Miller. Of Populus balsamifera, L., var. candicans, Gray, Prof. Sargent writes: "Rare and perhaps unknown in a wild state; very common in cultivation."

Review of the Catalogue.

The total number of plants, including both species and varieties, enumerated in this catalogue and appendix, is 1650, belonging to 557 genera, and representing 118 families or orders. Seven-tenths of the whole are exogenous: of which 480 are polypetalous, 512 gamopetalous, 149 apetalous, and 14 gymnospermous. Of the remaining three-tenths 427 are endogenous, and 68 are vascular cryptogams.

One-twelfth of this flora consists of introduced species, numbering 138: of which 120 are exogenous, 54 being polypetalous, 44 gamopetalous, and 22 apetalous; and 18 are endogenous. The twelve orders contributing most to this number are Compositæ, 18;

Gramineæ, 17; Cruciferæ, 12; Caryophyllaceæ, 9; Leguminosæ, 9; Labiatæ, 8; Polygonaceæ, 7; Solanaceæ, 6; Chenopodiaceæ, 6; Malvaceæ, 5; Umbelliferæ, 5; and Borraginaceæ, 5. One order and fifty-five genera are represented only by introduced species; leaving 117 orders, 502 genera, and 1512 species and varieties, occurring indigenously in this state.

Counting only indigenous plants, the twelve largest orders are as follows: Compositæ, 204; Cyperaceæ, 129; Gramineæ, 122; Leguminosæ, 62; Rosaceæ, 62; Ranunculaceæ, 45; Filices, 43; Orchidaceæ, 41; Cruciferæ, 39; Liliaceæ, 39; Scrophulariaceæ, 37; and Ericaceæ, 34; making 857, or nine-sixteenths of our native flora.

Again counting only indigenous species and varieties, the forty largest genera are Carex, 89; Aster, 34; Solidago, 28; Polygonum, 20; Ranunculus, 18; Viola, 17; Potamogeton, 16; Helianthus, 15; Juncus, 15; Potentilla, 14; Salix, 14; Aspidium, 13; Asclepias, Habenaria, and Panicum, each 12; Euphorbia, Quercus, and Scirpus, each 11; Anemone, Rubus, Galium, Artemisia, Gerardia, and Gentiana, each 10; Erigeron, Vaccinium, Pyrola, Eleocharis, and Poa, each 9; Arabis, Hypericum, Astragalus, Desmodium, Ribes, Cornus, Cnicus, Trillium, Cyperus, Elymus, Equisetum, and Lycopodium, each 8. In thirty-one of these genera, including the first three, no introduced plant is found.

Of the 412 species in Sargent's *Catalogue of the Forest Trees of North America* [north of Mexico], 81 occur indigenously in Minnesota; but eight of these, though becoming trees in some portions of the United States, do not here attain a tree-like size or habit of growth, while forty-eight (mostly noticed on pages 13 to 15) become large trees, at least forty or fifty feet high. Besides these, about 125 indigenous shrubs belong to this flora, making its whole number of woody plants about 206. Two species of Smilax are the only endogenous plants in this number.

In the statements of geographic range northward, very important aid has been derived from lists by Prof. John Macoun, of plants found in British America north of Minnesota, published in *Reports of Progress of the Geological and Natural History Survey of Canada* for 1875–76, 1878–79, and 1879–80; from his *Catalogue of Canadian Plants; Part I. Polypetalæ*, published as a report of the same survey, in 1883; and from manuscript notes, communicated by Professor Macoun, respecting the divisions of the flora after Polypetalæ. Toward the east, south and southwest, similar aid was found in Wheeler and Smith's *Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan:* 1881 (containing 1634 species and varieties, of which 1476 are indigenous);

COMPARISON WITH OTHER STATES AND WITH EUROPE.

ORDERS.	Genera.	Indigenous genera.	Species & varieties.	Indigenous species and varieties.	Indigenous species and varieties in the flora of Minnesota, also indigenous in						
					Europe.	N. England.	Michigan.	Wisconsin.	Iowa.	Nebraska.	California.
Ranunculaceæ	12	11	49	45	12	31	34	35	33	35	8
Menispermaceæ	1	1	1	1	......	1	1	1	1	1	......
Berberidaceæ	3	2	3	2	......	2	2	2	2	2	......
Nymphæaceæ	4	4	8	8	2	6	6	4	4	4	1
Sarraceniaceæ	1	1	1	1	......	1	1	1	1	1	......
Papaveraceæ	2	1	2	1	......	1	1	1	1	1	......
Fumariaceæ	3	2	7	6	......	4	4	5	2	4	......
Cruciferæ	18	18	51	39	11	20	27	27	28	27	11
Capparidaceæ	2	2	2	2	......	1	1	2	2	2	......
Violaceæ	1	1	18	17	2	15	14	12	10	8	2
Cistaceæ	3	3	3	3	......	3	2	3	2	2	......
Droseraceæ	1	1	3	3	1	2	3	3	......	1	1
Hypericaceæ	2	2	10	9	......	6	8	7	7	6	......
Caryophyllaceæ	7	5	24	15	8	11	13	11	8	10	5
Paronychieæ	1	1	1	1	......	1	1	1	1	1	......
Ficoideæ	1	1	1	1	......	......	1	1	1	......	1
Portulacaceæ	3	3	5	4	......	2	1	3	4	4	1
Malvaceæ	6	4	9	4	......	......	......	2	3	3	......
Tiliaceæ	1	1	1	1	......	1	1	1	1	1	......
Linaceæ	1	1	4	3	......	1	1	2	1	3	1
Geraniaceæ	4	3	9	8	2	8	8	8	6	7	2
Rutaceæ	2	2	2	2	......	1	2	2	2	2	......
Anacardiaceæ	1	1	7	7	......	7	7	5	5	5	......
Vitaceæ	2	2	5	5	......	5	4	4	4	3	......
Rhamnaceæ	2	2	3	3	......	3	3	3	2	3	1
Celastraceæ	2	2	3	3	......	1	3	2	2	3	......
Sapindaceæ	3	3	8	8	......	7	8	8	6	5	......
Polygalaceæ	1	1	6	6	......	6	6	6	3	6	......
Leguminosæ	27	24	71	62	4	31	38	42	43	52	6
Rosaceæ	13	13	62	62	12	49	51	49	39	42	12
Saxifragaceæ	8	8	23	22	4	16	19	19	8	17	4
Crassulaceæ	2	1	2	1	......	1	1	1	1	1	......
Hamamelaceæ	1	1	1	1	......	1	1	1	1	......	......
Halorageæ	2	2	4	4	3	3	4	3	3	4	2
Onagraceæ	5	5	18	18	6	12	14	15	12	16	7
Lythraceæ	3	3	3	3	......	1	2	3	2	2	1
Cactaceæ	1	1	3	3	......	......	1	3	2	3	......
Cucurbitaceæ	2	2	2	2	......	2	2	2	1	2	......
Umbelliferæ	22	17	32	27	2	19	22	22	19	22	4
Araliaceæ	1	1	5	5	......	5	5	5	3	4	......
Cornaceæ	1	1	8	8	......	7	7	6	5	7	1
Caprifoliaceæ	8	8	23	23	3	16	23	23	13	12	4
Rubiaceæ	4	4	14	14	4	11	14	13	10	11	5
Valerianaceæ	2	2	3	3	......	......	3	2	2	3	......
Dipsaceæ	1	......	1	......	......	......	......	......	......	......	......
Compositæ	58	48	222	204	9	101	141	151	139	154	32
Lobeliaceæ	1	1	6	6	1	6	6	5	4	5	......
Campanulaceæ	2	2	4	4	1	3	4	4	4	4	2
Ericaceæ	16	16	34	34	12	31	29	26	3	10	9
Ilicineæ	2	2	2	2	......	2	2	2	1	......	......
Plantaginaceæ	1	1	4	4	1	1	2	2	3	2	1
Primulaceæ	9	8	14	13	5	9	11	11	7	10	3
Lentibulaceæ	2	2	5	5	4	5	4	4	3	4	3
Orobanchaceæ	1	1	3	3	......	1	2	2	2	3	3
Scrophulariaceæ	18	17	41	37	5	25	30	30	24	25	7
Acanthaceæ	1	1	1	1	......	......	1	1	1	1	......
Verbenaceæ	3	3	8	7	......	4	6	7	7	7	2
Labiatæ	20	15	37	29	4	20	24	25	26	26	5
Borraginaceæ	8	6	20	15	2	8	10	10	12	18	2
Hydrophyllaceæ	3	3	5	5	......	1	3	3	3	5	1
Polemoniaceæ	3	3	6	6	......	......	2	4	4	6	1
Convolvulaceæ	2	2	8	8	1	4	6	6	6	6	......
Solanaceæ	6	2	14	8	1	1	6	7	5	5	2
Gentianaceæ	4	4	13	13	1	6	10	10	8	11	2
Apocynaceæ	1	1	2	2	......	2	2	2	2	2	2

ORDERS.	Gen.	I. g.	Sp.	I. sp.	Eu.	N. E.	Mich.	Wis.	Iowa.	Neb.	Cal.
Asclepiadaceæ....	2	2	17	17	......	11	8	13	14	12	1
Oleaceæ...........	1	1	5	5	......	4	5	5	4	5	......
Aristolochiaceæ ..	2	2	2	2	......	1	1	1	1	......	......
Nyctaginaceæ.....	1	1	3	3	......	......	.....	3	3	2	......
Phytolaccaceæ....	1	1	1	1	......	1	1	1	1	1	......
Chenopodiaceæ...	5	5	13	7	3	1	2	2	1	5	4
Amarantaceæ.....	3	3	5	3	......	1	1	2	3	2	1
Polygonaceæ......	3	2	33	26	5	21	24	22	19	19	9
Thymeleaceæ	1	1	1	1	......	1	1	1	1	......	......
Elæagnaceæ.......	2	2	3	3	......	1	1	1	......	2	1
Santalaceæ........	1	1	3	3	......	1	2	1	1	1	2
Saururaceæ........	1	1	1	1	......	1	1	1	......	1	......
Ceratophyllaceæ..	1	1	1	1	1	1	1	1	1	1	1
Callitrichaceæ.....	1	1	1	1	1	1	1	1	1	1	1
Podostemaceæ....	1	1	1	1	......	1	1	......	......	......	......
Euphorbiaceæ.....	2	2	13	12	......	4	5	9	10	9	2
Empetraceæ.......	1	1	1	1	......	1	1	1	......	......	......
Urticaceæ.........	10	9	13	11	1	11	11	11	10	11	......
Platanaceæ........	1	1	1	1	......	1	1	1	1	1	......
Juglandaceæ......	2	2	5	5	......	5	5	5	4	4	......
Cupuliferæ	4	4	15	15	......	14	12	14	13	13	1
Myricaceæ.........	2	2	2	2	1	2	2	2	......	2	......
Betulaceæ.........	2	2	8	8	2	8	7	6	3	5	2
Salicaceæ..........	2	2	23	19	1	18	17	17	14	13	4
Coniferæ..........	7	7	13	13	3	13	12	12	4	3	1
Taxaceæ...........	1	1	1	1	......	1	1	1	1	......	......
Araceæ............	4	4	5	5	2	5	5	5	4	4	......
Lemnaceæ.........	3	3	4	4	3	4	4	3	3	3	3
Typhaceæ....	2	2	7	7	4	7	6	5	4	4	3
Naidaceæ.....	3	3	18	18	10	16	16	12	13	7	12
Alismaceæ	5	5	10	10	4	8	9	6	7	7	4
Hydrocharidaceæ.	2	2	2	2	1	2	2	2	2	2	1
Orchidaceæ	14	14	41	41	10	36	40	34	14	26	9
Amaryllidaceæ....	1	1	1	1	......	1	1	1	1	1	......
Hæmodoraceæ ...	1	1	1	1	......	1	1	1	......	......	......
Iridaceæ...........	2	2	2	2	......	2	2	2	2	2	......
Dioscoreaceæ	1	1	1	1	......	1	1	1	1	1	......
Smilaceæ..........	1	1	4	4	......	3	4	4	2	2	......
Liliaceæ...........	18	17	40	39	4	25	34	31	25	32	5
Juncaceæ..........	2	2	18	18	9	12	16	12	9	10	7
Pontederiaceæ....	2	2	2	2	......	2	2	2	2	2	1
Commelynaceæ...	1	1	1	1	......	......	1	1	1	1	......
Xyridaceæ.........	1	1	1	1	......	1	1	......	......	1	......
Eriocaulonaceæ..	1	1	1	1	......	1	1	......	......	1	......
Cyperaceæ.........	10	10	129	129	37	105	113	95	69	92	39
Gramineæ	47	42	139	122	30	89	96	92	79	89	48
Equisetaceæ.......	1	1	8	8	6	6	7	8	4	8	3
Filices...	15	15	43	43	19	36	40	32	22	29	11
Ophioglossaceæ...	2	2	5	5	4	4	4	3	2	2	2
Lycopodiaceæ....	1	1	8	8	5	8	7	5	1	2	2
Selaginelleæ.......	1	1	2	2	1	2	2	2	1	1	1
Marsiliaceæ	1	1	1	1	......	......	......	......	1	1	1
Salviniaceæ	1	1	1	1	......	......	......	......	......	1	1
118 Orders.....	557	502	1650	1512	290	1048	1210	1176	949	1091	335

G. D. Swezey's *Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Wisconsin*, forming chapter V in *Geology of Wisconsin*, vol. I: 1883 (containing 1473 species and varieties, of which 1337 are indigenous); J. C. Arthur's *Contributions to the Flora of Iowa*, numbers I to VI: 1876 to 1884 (containing 1210 species and varieties, of which 1097 are indigenous); and Prof. Samuel Aughey's *Catalogue of the Flora of Nebraska:* 1875 (containing 1718 species and varieties of phænogams and vascular cryptogams, of which

1648 are indigenous). Acknowledgment is also due to Mr. Arthur for valuable information and suggestions during this work.

The preceding table presents comparisons with the four state catalogues mentioned; and also with the *Botany of California* (1876 and 1880; by Brewer, Gray, and Watson; 2894 species and 339 varieties, including introduced plants); with the flora of New England, as indicated by Gray's *Manual* (approximately 1364 species and varieties of native phænogams, 243 introduced phænogams, and 74 vascular cryptogams); and with the flora of Europe, so far as it is represented in that of the northern United States, also shown by Gray's *Manual*. From this table it appears that 290 species and varieties of the indigenous flora of Minnesota are also found native in Europe; 1048 in New England; 1210 in Michigan; 1176 in Wisconsin; 949 in Iowa; 1091 in Nebraska; and 335 in California.

In submitting this catalogue to readers, students and botanists, it seems desirable to repeat that it claims to be merely a report of progress in an unfinished work. It is hoped that its publication will incite all the workers in this field to increased efforts, so that the final report of this part of the state survey shall be made as complete and accurate as possible. The cryptogamic vegetation, as mosses, liverworts, lichens, fungi, and algæ, will there be catalogued; and within the province of the present work, there will be incorporated additions and corrections, as well as extension or more exact limitation in statements of the range of species, so far as known. For this purpose, botanists are requested to keep full notes of all observations that supplement or amend this catalogue, and to send them, together with specimens of plants found in Minnesota but not herein recorded, to Prof. N. H. Winchell, curator of the state university museum, Minneapolis.

Probably about a tenth part of the total phænogamous flora of the state remains yet to be noted in neglected nooks, in marsh, dense woods, cool ravines, on cliffs and hills, in streams and lakes. Numerous species and varieties new to science quite certainly await discovery; and it will be interesting in many cases to compare our common and well known plants with specimens of the same gathered in distant portions of the country, or even in this region under differing conditions of soil, moisture, or shade. The greater part of the accessions must be expected, of course, near the borders of the state, being often species that are common or frequent beyond our limits but extend only scantily into Minnesota.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. 112 pp., 8vo.; with a colored map of the state. By *N. H. Winchell.* Published in the Regents' Report for 1872. Out of print. Second edition issued, 1884.

The Second Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1873. 145 pp., 8vo.; with illustrations. By *N. H. Winchell* and *S. F. Peckham.* Published in the Regents' Report for 1873. Out of print.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. 42 pp., 8vo.; with two county maps. By *N. H. Winchell.* Published in the Regents' Report for 1874. Out of print.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. 162 pp., 8vo.; with four county maps and a number of other illustrations. By *N. H. Winchell*, assisted by *M. W. Harrington.* Also in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. 248 pp., 8vo.; four colored maps and several other illustrations. By *N. H. Winchell;* with reports on Chemistry by *S. F. Peckham,* Ornithology by *P. L. Hatch,* Entomology by *Allen Whitman,* and on Fungi by *A. E. Johnson.* Also in the Regents' Report for 1876.

The Sixth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1877. 226 pp., 8vo.; three geological maps and several other illustrations. By *N. H. Winchell;* with reports on Chemical Analyses by *S. F. Peckham,* on Ornithology by *P. L. Hatch,* on Entomology by *Allen Whitman,* and on Geology of Rice county by *L. B. Sperry.* Also in the Regents' Report for 1877. Out of print.

The Seventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1878. 123 pp., 8vo.; with twenty-one plates. By *N. H. Winchell;* with a Field Report by *C. W. Hall,* Chemical Analyses by *S. F. Peckham,* Ornithology by *P. L. Hatch,* a list of the Plants of the north shore of Lake Superior by *B. Juni,* and an Appendix by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota (twenty-one plates). Also in the Regents' Report for 1878.

LIST OF PUBLICATIONS.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 183 pp., 8vo.; one plate (Castoroides). By *N. H. Winchell*. Containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, and descriptions of new species of brachiopoda from the Trenton and Hudson River formations; with reports on the Geology of Central and Western Minnesota, by *Warren Upham;* on the Lake Superior region, by *C. W. Hall;* lists Birds and of Plants from Lake Superior, by *Thomas S. Roberts;* Chemical Analyses by *S. F. Peckham;* report by *P. L. Hatch;* and four Appendixes. Also in the Regents' Report for 1879 and 1880.

THE NINTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1880. 392 pp., 8vo.; three appendixes, two wood-cut illustrations, and six plates. By *N. H. Winchell*. Containing field descriptions of 442 crystalline rock samples, and notes on their geological relations, from the northern part of the state; new brachiopoda; the water supply of the Red River Valley, and simple tests of the qualities of water; with reports on the Upper Mississippi region, by *O. E. Garrison;* on the Hydrology of Minnesota, by *C. M. Terry;* on the Glacial Drift and its Terminal Moraines, by *Warren Upham;* Chemical Analyses by *J. A. Dodge;* a list of the Birds of Minnesota, by *P. L. Hatch;* and of the Winter Birds, by *Thomas S. Roberts*. Also in the Regents' Report for 1879 and 1880.

THE TENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1881. 254 pp., 8vo.; with ten wood-cut illustrations, and fifteen plates. By *N. H. Winchell*. Containing field descriptions of about 400 rock samples and notes on their geological relations, continued from the last report; the Potsdam sandstone; typical thin sections of the rocks of the Cupriferous Series; and the deep well at the "C" Washburn mill, Minneapolis; with Geological notes by *J. H. Kloos;* Chemical Analyses by *J. A. Dodge;* and papers on the Crustacea of the fresh waters of Minnesota (eleven plates), by *C. L. Herrick*. Also in the Regents' Report for 1881 and 1882.

THE ELEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1882. 219 pp., 8vo.; with three wood-cut illustrations and one plate. By *N. H. Winchell*. Containing a report on the Mineralogy of Minnesota, and a note on the Age of the rocks of the Mesabi and Vermilion iron districts; with papers on the Crystalline rocks of Minnesota, by *A. Streng* and *J. H. Kloos;* on Rock outcrops in central Minnesota, and on Lake Agassiz, by *Warren Upham;* on the Iron region of northern Minnesota, by *Albert H. Chester;* Chemical Analyses by *J. A. Dodge;* and an Appendix containing Minnesota Laws relating to Mines and Mining, abstracted by *C. L. Herrick*. Also in the Regents' Report for 1881 and 1882.

II. FINAL REPORT.

THE GEOLOGY OF MINNESOTA. VOL. I. OF THE FINAL REPORT. 1884; xiv and 697 pp., quarto; illustrated by 43 plates and 52 figures. By *N. H. Winchell*, assisted by *Warren Upham*. Containing an Historical sketch of Explorations and Surveys in Minnesota, the general Physical features of the state, the Building stones, and the Geology of Houston, Winona, Fillmore, Mower, Freeborn, Pipestone, Rock and Rice counties, by *N. H. Winchell;* the Geology of Olmsted, Dodge and Steele counties, by *M. W. Harrington;* and the Geology of Waseca, Blue Earth, Faribault, Watonwan, Martin, Cottonwood, Jackson, Murray, Nobles, Brown, Redwood, Yellow Medicine, Lyon, Lincoln, Big Stone, Lac qui Parle and Le Sueur counties, by *Warren Upham*. Distributed gratuitously to all public libraries and county auditors' offices in the state, to other state libraries and state universities, and to leading geologists and scientific societies; the remainder are held for sale at the cost of publication, $3.50 per copy in cloth, or $5 in grained half roan binding, upon application to Prof. N. H. Winchell, Minneapolis.

III. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. A copy of the law ordering the survey, and a note asking the co-operation of citizens and others. 1872.
2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham.*
3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. A history of all official transactions relating to them, and a statement of their amount and location. 1874. By *N. H. Winchell.*
4. A CATALOGUE OF THE PLANTS OF MINNESOTA; prepared in 1865 by *Dr. I. A. Lapham*, contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.
5. CIRCULAR No. 2. Relating to Botany, and giving general directions for collecting information on the flora of the state. 1876.
6. CIRCULAR No. 3. The establishment and organization of the Museum. 1877.
7. CIRCULAR No. 4. Relating to duplicates in the Museum and exchanges. 1878.
8. THE BUILDING STONES, CLAYS, LIMES, CEMENTS, ROOFING, FLAGGING AND PAVING STONES OF MINNESOTA. A special report by *N. H. Winchell.* 1880.
9. CIRCULAR No. 5. To Quarrymen and Builders. Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum. 1880.
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